

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

UNITED STATES OF AMERICA,
et al.,

Plaintiffs,

vs.

GOOGLE, LLC,

Defendant.

Civil Action

No. 1:20-cv-3010

Washington, DC

October 18, 2023

1:32 p.m.

Day 24

Afternoon Session

TRANSCRIPT OF BENCH TRIAL
BEFORE THE HONORABLE AMIT P. MEHTA
UNITED STATES DISTRICT JUDGE

APPEARANCES:

For DOJ Plaintiffs:

KENNETH DINTZER

U.S. Department of Justice
1100 L Street, NW
Washington, DC 20005

MEAGAN BELLSHAW

U.S. Department of Justice
450 Fifth Street, NW
Washington, DC 20001

DAVID DAHLQUIST

U.S. Department of Justice
209 South LaSalle Street, Suite 600
Chicago, IL 60604

For Plaintiffs
State of Colorado &
State of Nebraska:

WILLIAM CAVANAUGH, JR.

Patterson, Belknap, Webb & Tyler, LLP
1133 Avenue of the Americas #2200
Suite 2200
New York, NY 10036

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

APPEARANCES CONT:

**For Plaintiff
State of Colorado:**

**JONATHAN SALLET
STEVEN KAUFMANN**

Colorado Department of Law
CPS/Antitrust Section
1300 Broadway, 7th Floor
Denver, CO 80203

For Defendant Google:

**JOHN SCHMIDTLEIN
KENNETH SMURZYNSKI**

Williams & Connolly, LLP
680 Maine Avenue, SW
Washington, DC 20024

WENDY HUANG WASZMER

Wilson, Sonsini, Goodrich & Rosati
1301 Avenue of the Americas, 40th Fl.
New York, NY 10019

Court Reporter:

JEFF HOOK

Official Court Reporter
U.S. District & Bankruptcy Courts
333 Constitution Avenue, NW
Washington, DC 20001

I N D E XWITNESSPAGE

P. PANDURANG NAYAK

Cross-Examination by Mr. Dintzer

6395

Redirect Examination by Mr. Smurzynski

6468

E X H I B I T SEXHIBITPAGE

Exhibit UPX680Admitted into evidence.....

6435

Exhibit UPX2034Admitted into evidence.....

6451

Exhibit UPX2026Admitted into evidence.....

6455

Exhibit UPX2022Admitted into evidence.....

6458

Exhibit UPX2027Admitted into evidence.....

6462

Exhibit UPX2033Admitted into evidence.....

6465

P R O C E E D I N G S

THE COURT: Welcome back, everybody.

We're ready to proceed, Mr. Dintzer?

MR. DINTZER: Yes, Your Honor. The defense helped us and worked with us, and I think we're going to be able to do this in open court.

THE COURT: Good.

MR. DINTZER: And they'll let me know if I wander outside the line.

THE COURT: Okay.

MR. DINTZER: May we approach?

THE COURT: Sure.

MR. DINTZER: Thank you.

CROSS-EXAMINATION OF P. PANDURANG NAYAK

BY MR. DINTZER:

Q. Good afternoon, sir. My name is Kenneth Dintzer. Nice to meet you.

A. Nice to meet you.

Q. I'm going to start off with a broad question. How much user data does Google maintain at this point? So if I put in a search about Taylor Swift, how long will any system at all in Google have that recorded?

A. I don't know if I can give a specific answer, but I think to the extent that it is anonymized and de-identified, I think they may well keep it -- I don't know that they would

1 delete it.

2 Q. Oh, forever?

3 A. Well --

4 Q. Forever's a long time.

5 A. Forever's a long time, so I would not say that.

6 Q. Indefinitely?

7 A. But, yeah, I'm not aware -- I'm not the expert on how
8 long they store logs. So it's possible that they delete it,
9 but I'm not aware of that.

10 Q. Okay. And so -- and just to be clear, sir, you've
11 never worked at Microsoft; is that right?

12 A. I have not worked at Microsoft.

13 Q. And if I asked you detailed questions about how their
14 search stack worked and the modules for it, you wouldn't know;
15 is that right?

16 A. I wouldn't -- I might hazard a guess, but that would
17 be what it would be.

18 Q. And it's true for both Google's and Bing's search
19 systems, they're proprietary; is that right?

20 A. I think most of it is proprietary, yeah.

21 Q. And so somebody who hasn't actually had realtime
22 experience working on one of those systems wouldn't know how
23 they work or how to work them; is that fair?

24 A. Again, they might understand the overall principles,
25 because those are sort of maybe well understood, but the

1 details, probably not.

2 Q. And do you agree with the statement that Microsoft
3 used more machine learning than Google in 2014 and 2015?

4 A. We had heard that Microsoft uses a lot of machine
5 learning, yes.

6 Q. And had you heard that Microsoft was using more
7 machine learning than Google in 2015, '16, '17?

8 A. No, that I had not heard.

9 Q. You talked about Google's index size. In 2020, the
10 index was about 400 billion documents; is that right?

11 A. I don't know the specific number, but maybe.

12 Q. Okay. And -- but I think you testified that that
13 number had come down; is that right?

14 A. There was a period of time when that number did come
15 down.

16 Q. And the decrease in size was concerning to the
17 engineers like you at Google?

18 A. Because we want to build a comprehensive index, yes.

19 Q. And all else equal, bigger is better for an index?

20 A. Other than the fact that all else is rarely equal --

21 Q. Fair enough.

22 A. But we do want to create a comprehensive index, yes.
23 I think that's fair to say.

24 Q. And a bigger index -- wherever you're starting from, a
25 bigger index requires more investment, right?

1 A. It requires not just more investment, but bigger is
2 not necessarily better, because you might fill it with junk.

3 Q. Well, fair enough.

4 A. So you need a fair amount of investment to figure out
5 what you're going to fill that with. And you can keep the size
6 of the index the same if you decrease the amount of junk in it.

7 Q. Fair enough.

8 A. Which will still improve the quality of the index.

9 Q. Fair enough. My question, though, is if you want to
10 increase the amount of information that the index holds, you
11 would have to spend more money, right?

12 A. I mean, certainly that could be one way to do it.
13 But, again, I think figuring out how to get more information in
14 would be another way, right, by removing stuff that is not good
15 information.

16 Q. Has Google increased the overall carrying capacity of
17 its index in the past three years?

18 A. The past three years?

19 Q. Yeah. So just -- I understand what you're saying
20 about quality, and that's not my question. If it held X at one
21 time, over the past three years, do you know if its capacity is
22 now X plus?

23 A. So I don't know in the past three years if there's
24 been a specific change in the size of the index.

25 Q. Now, on receiving a query -- and you talked about some

1 of this, Google uses the index to retrieve pages matching the
2 query, right?

3 A. Yes.

4 Q. And typically there are many results matching the
5 query?

6 A. Yes.

7 Q. And a simple match could yield as many as 10,000,000
8 results, right?

9 A. Yes.

10 Q. Okay. And I'm going to go to the demonstrative that
11 you all prepared, which I think is really helpful. Let's go to
12 DXD17.002 -- and if I could convey upon you to pull it up.

13 So we were talking about how Google goes from one circle
14 to the other, as part of your direct. Google uses what you've
15 called core algorithms to bring that down to a set of about 200
16 documents, right?

17 A. Several hundred, yes.

18 Q. Several hundred. And I'm just going to write "core
19 algorithm," because I'm probably going to use that.

20 And those algorithms give the documents initial rankings
21 or scores, right?

22 A. Yes.

23 Q. And once Google has the smaller set of documents, then
24 the deep learning can be used to adjust the score?

25 A. Yes.

1 Q. The core ranking algorithms are critical, because if
2 they don't bring up the right documents, then, for the most
3 part, the deep learning systems can't do their role in figuring
4 out which are the best ones?

5 A. Some of the deep learning systems are also involved in
6 the retrieval process, like we discussed, like the RankEmbed
7 system.

8 Q. Yes, but --

9 A. But unless we retrieve the right documents, you can't
10 score them, yes.

11 Q. But most of the retrieval process happens under the
12 core system, right?

13 A. Other than, as I said, the RankEmbed thing also does
14 retrieval.

15 **THE COURT:** I'm sorry, you said RankEmbed?

16 **THE WITNESS:** Yes. RankEmbed bought one of those deep
17 learning systems that also does retrieval.

18 **BY MR. DINTZER:**

19 Q. And we're going to come back to that. But the ranking
20 system -- the core gives them scoring, right?

21 A. Yes.

22 Q. And the core algorithms are critical, because if they
23 don't bring up the right documents, then even RankEmbed doesn't
24 go back and redo the work that the core system is supposed to
25 do, right?

1 A. I mean, it could, but -- so right now it doesn't, yes.

2 Q. And at the end, each page that matches a query, it
3 gets a score?

4 A. Yes.

5 Q. And then Google sorts the scores, and that's what's
6 used in part for Google to present to the users?

7 A. Yes.

8 Q. Now, Google puts a bunch of different things on its
9 SERP, right?

10 A. Yes.

11 Q. And if I use this term SERP, we'll both understand
12 it's a search engine results page?

13 A. Yes.

14 Q. Web results are only one of the things that come --
15 that get shown on the SERP?

16 A. That is correct.

17 Q. And web results are scored with something called an IR
18 score, right?

19 A. That's right.

20 Q. And IR stands for information retrieval?

21 A. Yes.

22 Q. And you talked about search features earlier, and
23 search features are basically some of the other things that
24 appear on the SERP that are not the web results?

25 A. That is correct.

1 Q. And those features get a different score, they don't
2 get an IR score, right?

3 A. They do get a score, but yes.

4 Q. So let's go to DXD1705, and this is one of the
5 demonstratives. Just let me know when you're there, sir.

6 A. Oh, this one here?

7 Q. Yes, sir. And you're welcome to use the screen.

8 A. Okay.

9 Q. And so just to level set here, what you've included --
10 and I understand this was talking about the machine learning,
11 right?

12 A. Yes, yes.

13 Q. So you left off the core systems on this?

14 A. Yes.

15 Q. And so one of the core systems is navboost, right?

16 A. Yes.

17 Q. And navboost dates to a long time ago, right? I
18 mean --

19 A. Yes.

20 Q. -- it's all the way off the screen?

21 A. Yes.

22 Q. So remind me, is navboost all the way back to 2005?

23 A. It's somewhere in that range. It might even be before
24 that.

25 Q. And it's been updated. It's not the same old navboost

1 that it was back then?

2 A. No.

3 Q. And another one is glue, right?

4 A. Glue is just another name for navboost that includes
5 all of the other features on the page.

6 Q. Right. I was going to get there later, but we can do
7 that now. Navboost does web results, just like we discussed,
8 right?

9 A. Yes.

10 Q. And glue does everything else that's on the page
11 that's not web results, right?

12 A. That is correct.

13 Q. Together they help find the stuff and rank the stuff
14 that ultimately shows up on our SERP?

15 A. That is true. They're both signals into that, yes.

16 Q. Now let's go to DXD17-4. So navboost helps us get
17 from the green ring to the blue ring, right?

18 A. No, navboost doesn't help you -- I mean, it's
19 certainly a factor, but it's not the only factor by any means.

20 Q. Fair enough. Navboost and glue are factors that help
21 us get from the green ring to the blue ring?

22 A. Not glue, just navboost.

23 Q. Oh, because this is just web results?

24 A. Yes.

25 Q. And glue works on all those other things?

1 **A.** Which is much later in the stack.

2 **Q.** Okay. And this sort of helps -- the Court asked the
3 question -- and I'm going to try to help us through the Court's
4 question, which is: How do these pieces fit together?

5 So what happens is navboost is reaching in, and after the
6 set has been culled to the green ring, navboost reaches in and
7 helps pull us -- a lot of the documents, not all of them, into
8 the blue ring; is that right?

9 **A.** It helps. It's certainly a factor, yes.

10 **Q.** And then in machine learning -- we're going to get to
11 these -- they then take a look at that set, and they may say,
12 well, we need a few more to add to it. But one of the things
13 that they do is once you've got the navboost set, they then try
14 to figure out which are the better ones and sort through them?

15 **A.** I wouldn't characterize it as the navboost set, but
16 once we get it down to the smaller set, that's what they work
17 on. And navboost is a factor there, but by no means the only
18 factor.

19 **Q.** Now, the core ranking algorithms, those are -- I think
20 you also, in your deposition, called them traditional systems,
21 right?

22 **A.** I don't remember that phrase, but maybe that's a
23 reasonable characterization.

24 **Q.** They need to operate with many more documents than the
25 machine learning documents, right?

1 **A.** Yes, that's correct.

2 **Q.** And that's -- I think it's important for the Court to
3 understand. These -- not glue. Navboost is looking at a lot
4 of documents and figuring out things about it. Machine
5 learning is kind of -- is more looking at a much smaller set,
6 right?

7 **A.** And it's not just navboost, it's all the other factors
8 also, yes.

9 **THE COURT:** Just to be clear, you're talking about in
10 the -- what you've called the search stack, none of those are
11 the sequencing?

12 **THE WITNESS:** Yes. So it's the thing that culls from a
13 lot of documents to fewer documents, yes.

14 **BY MR. DINTZER:**

15 **Q.** Now, the navboost system memorizes past clicks that
16 have been issued for past queries, right?

17 **A.** Yes.

18 **Q.** It's trained on user data?

19 **A.** Yes, it is.

20 **Q.** And navboost memorizes this information for all
21 queries received in the past 13 months?

22 **A.** That is correct.

23 **Q.** And before 2017, navboost memorized this information
24 for all queries received for 18 months?

25 **A.** Yes.

1 Q. Now, you talked about reducing the amount of data used
2 by navboost, I think that you looked at a document.

3 A. Yes, we did.

4 Q. And I'm going to ask if we can go back to that
5 document, and that's DX108, please.

6 **THE COURT:** Can I interrupt for a moment, I'm sorry, just
7 to make sure I understand this conceptually. I think you've
8 already explained this, but what's the relationship between the
9 index and the culling function that navboost is a signal for?

10 **THE WITNESS:** So when you have a query, you need to go and
11 retrieve documents from the index that match the query. The
12 core of that is the index itself. Remember, the index is for
13 every word, what are the pages on which that word occurs. And
14 so -- this is called an inverted index for various reasons.
15 And so the core of the retrieval mechanism is looking at the
16 words in the query, walking down the list -- it's called the
17 postings list -- and intersecting the postings list. This is
18 the core retrieval mechanism. And because you can't walk the
19 lists all the way to the end because it will be too long, you
20 sort the index in such a way that the likely good pages, which
21 are high quality -- so sometimes these are sorted by page rank,
22 for example, that's been done in the past, are sort of earlier
23 in the thing.

24 And once you've retrieved enough documents to get it down
25 to tens of thousands, you hope that you have enough documents.

1 So this is the core of the retrieval mechanism, is using the
2 index to walk down these postings lists and intersect them so
3 that all the words in the query are retrieved.

4 **THE COURT:** And the ranking is done only after you have
5 culled it to the tens of thousands?

6 **THE WITNESS:** Exactly. So that's -- the next phase is to
7 say, okay, now I've got tens of thousands. Now I'm going to
8 use a bunch of signals to rank them so that I get a smaller set
9 of several hundred. And then I can send it on for the next
10 phase of ranking which, among other things, uses the machine
11 learning.

12 **THE COURT:** Okay, thank you.

13 **BY MR. DINTZER:**

14 **Q.** Let's see if I can get this right. So index, it gets
15 culled to tens of thousands?

16 **A.** Yes.

17 **Q.** Navboost gets us to 2- to 300? I understand it's
18 imprecise.

19 **A.** I wouldn't quite say navboost gets us to 2- to 300,
20 because there might be lots of documents that don't have
21 clicks. So I think it is fair to say that navboost is not the
22 only factor.

23 **Q.** Okay. And are there other core systems here that are
24 taking us from 10K to 300?

25 **A.** Yes. All of our core topicality signals, our page

1 rank signals, our localization signals. There's all kinds of
2 signals in there that look at these tens of thousands of
3 documents and together create a score that then you extract the
4 top few hundred from there.

5 Q. And then deep learning gives it a chance to work with
6 that?

7 A. Yeah.

8 Q. And then we talked about glue. Glue gets a chance to
9 add search features that aren't -- this is all just web, gets a
10 chance to add search features that aren't retrieved through the
11 web, right?

12 A. So, once again, even for the search features that are
13 added up, glue is one signal. It's not, again, the only
14 signal. So I would not characterize it as glue gets to do
15 this. It's the Tangram system that does that, which takes
16 other inputs, other signals also.

17 Q. Right. Tangram used to be called Tetris, right?

18 A. Tangram used to be called Tetris, yes.

19 Q. And it was called Tetris because it was putting the
20 pieces together on the search engine results page?

21 A. Maybe.

22 Q. Okay. But glue is giving one of the signals to figure
23 out what are the best search features for the Tetris --

24 A. It's one of the signals, yes.

25 Q. And then that finally takes us to the SERP?

1 A. Yeah.

2 Q. Now let's go to DX108. That will be in the binder
3 that Google gave you. Let me know when you're there, sir.

4 A. I am there.

5 Q. Okay. And so this reduction that you talked about,
6 this took place in 2017, right?

7 A. Yes.

8 Q. And Google ran several experiments before reducing the
9 data used in its navboost model, right?

10 A. I have not looked at this carefully to know if they
11 did, but I'd be surprised if they did not run several
12 experiments.

13 Q. So you weren't involved in the 2017 ablation studies
14 that led to the reduction?

15 A. I was involved in the decision to launch it, but I did
16 not actively work on it.

17 Q. But you wouldn't have signed off on reducing the
18 amount of data that navboost used without a fair amount of
19 experimentation to sign off on it, right?

20 A. Without adequate experimentation, yes.

21 Q. And we can look at the document. The three types of
22 experiments were -- involved random traffic evaluation
23 experiments, right?

24 A. Yes.

25 Q. We can go to page 129.

1 A. Yeah.

2 Q. And if you look under the heading Overview.

3 A. Yeah.

4 Q. Oh, I'm sorry, at the top, "experiment types," do you
5 see that? We have the random traffic experiment?

6 A. Yeah.

7 Q. That was -- and then the second one was an impact to
8 traffic. Do you see that?

9 A. Yes.

10 Q. And that was a side-by-side experiment?

11 A. Yes.

12 Q. And a side-by-side experiment is where Google takes
13 sort of -- it's A/B, whatever the standard is and whatever it
14 wants to test against it, and it puts them together in front of
15 the evaluator, right?

16 A. Yes.

17 Q. And then the evaluator picks which of the two are
18 better on a side-by-side test, and it uses that information to
19 make sure that this is what it wants to do, right?

20 A. Yes.

21 Q. And in deciding to go from 18 months to 13 months,
22 that was a big choice, a big decision, right?

23 A. It was a decision.

24 Q. An important one, right?

25 A. I mean, there are many important decisions we take, so

1 I wouldn't go there. But yes.

2 Q. Well, I appreciate that you make many important
3 decisions, sir. But the decision to reduce the amount of
4 actual data that you're training navboost on, that was an
5 important decision for Google, right?

6 A. In the scheme of things, it wasn't so important, I
7 don't think.

8 Q. Okay. And so then the next thing that your team
9 did -- or the people who worked for you did is they did a live
10 experiment, right?

11 A. Okay, yes.

12 Q. A live experiment is when some users are shown X and
13 some users are shown Y, and you figure out if the users that
14 are shown one or the other are getting the better or the same
15 experience, right?

16 A. Actually, these are so-called mode server experiments,
17 where results from the two sides are interleaved in this way,
18 and so users only see one ordering, which is the interleaved
19 ordering.

20 Q. I see. And then you figure out which ones they click
21 on so you can use that to determine which are the better
22 results?

23 A. Yeah, and so there's a particular technique to decide
24 which side is better.

25 Q. That would be an example of using click data to run an

1 experiment?

2 A. Yes.

3 Q. Now, users are served results in part based on their
4 locale, right?

5 A. Yes.

6 Q. The meaning of a word in a query can change depending
7 on where you are?

8 A. Yes.

9 Q. And if you're a football fan in the United States, you
10 like to root for people to move something that's oblong and
11 brown, and if you're a football fan in the UK, then you're
12 rooting for somebody to kick something that's round, right?

13 A. Absolutely.

14 Q. And if you're searching for pizza, the word "pizza,"
15 you want a pizza restaurant -- I think you mentioned this in
16 your direct -- around the corner from you, not necessarily the
17 best pizza place in the world?

18 A. That's right.

19 Q. And navboost, navboost slices -- I think you used the
20 word "slice" in your deposition. Navboost slices the locale
21 information; is that right?

22 A. The navboost does slice locale information, yes.

23 Q. And it slices the data information that it has in it
24 by locale?

25 A. Yes.

1 Q. Navboost also slices the data information by mobile
2 versus desktop?

3 A. Yes, it does.

4 Q. And slicing here means that navboost is creating
5 different datasets for each of these categories?

6 A. That is correct.

7 Q. And there are differences in user intent on mobile and
8 desktop. I think you talked about this in your direct?

9 A. Yes.

10 Q. You used the Bank of America example?

11 A. Yes, I did.

12 Q. To some extent, that's navboost, right, picking the --
13 oh, we're looking for local branches, we're not looking for
14 online banking?

15 A. Navboost certainly provides that signal, yes.

16 Q. Now, you're familiar with the Search Quality
17 Newsletter; is that right?

18 A. Yes, I am.

19 Q. And what is it?

20 A. It's a newsletter I publish weekly.

21 Q. The newsletters are usually an in-depth article going
22 to the technical details of some particular subject; is that
23 right?

24 A. Yes, that is correct.

25 Q. And you view them as an educational tool?

1 A. Yes.

2 Q. So we're going to go in the binder that I handed you.
3 In the binder that I handed you, we're going to go to 1087.

4 **MR. DINTZER:** This is admitted, Your Honor.

5 Q. And just let me know when you have it there, sir.

6 A. Yes, I'm there.

7 Q. Thank you. And so this is an example of the
8 newsletter from third quarter -- from August 11th to
9 August 15th, 2014; is that right?

10 A. That is correct.

11 Q. We're going to go to the page with the Bates number --
12 it's three pages in, with the Bates number 1720 at the bottom.

13 A. Yeah.

14 Q. Okay. And at the top it says -- and you would have
15 seen this newsletter, right?

16 A. I would have seen it, yes.

17 Q. And it says: "Given this, a question which we need to
18 answer is whether mobile search is different from desktop
19 search. If so, how are they different? To answer to this
20 question, we conducted some analyses, focusing on user intents
21 and behaviors."

22 Do you see that?

23 A. Yes.

24 Q. And that's what this article discusses, the analysis
25 between mobile and desktop?

1 A. Yes.

2 Q. And then we go to the next page, X1721, and there's a
3 heading that says: "Top intents of mobile dominant queries."

4 Do you see that?

5 A. Yes.

6 Q. And what does "top intents" mean there, sir, just that
7 term?

8 A. I think they're looking at -- for queries that are
9 mobile-dominant, what kind of intents do users have. Not for
10 mobile queries at large, but queries that are mobile-dominant
11 that is usually -- that the occurrence on mobile is
12 meaningfully higher than on desktop.

13 Q. Okay. And so the -- so we combined some things here.
14 I just want to break them down. Is it the fact that they occur
15 more on mobile or is it the fact that their being on mobile
16 means something different than if they had been issued by a
17 desktop?

18 A. No, the mobile-dominant part says they occur more
19 frequently on mobile. That's the table further up there.

20 Q. And the top intent is that I have some sort of mobile
21 intent when I put it in?

22 A. So then the question is for those mobile-dominant
23 queries, the question is what was the intent on those queries.

24 Q. Okay. And then to the next page, we have the heading
25 "Top intents of desktop-dominant queries."

1 Do you see that?

2 A. That is correct.

3 Q. It says -- after the box it says: "The top intent
4 includes queries for work."

5 Do you see that?

6 A. Yes.

7 Q. "More specifically, there are many queries" -- "many
8 queries related to professional or industrial office work, and
9 also queries for school homework."

10 Do you see that?

11 A. Yes.

12 Q. So for people searching on desktop, they are more
13 likely to be at work or at school, right?

14 A. They could be at home, I guess.

15 Q. But doing homework or schoolwork?

16 A. I think people other than students are also at home
17 doing other kinds of research. I would not generalize to say
18 that the only desktop users are students.

19 Q. Well, that's fair. But it does say that there are
20 many queries related to professional or industrial office
21 work --

22 A. Certainly, there are many queries, but there are many
23 other queries also is what it says.

24 Q. Fair enough. No, you're right. I didn't mean to
25 gather all the queries and just put them in as workers. Now,

1 for people searching -- I'm sorry, for each query, Google
2 tracks what kind of device it is made on. That's how it knows
3 the difference between desktop and mobile, right?

4 A. Yes.

5 Q. And if we go to the bottom of this page, it says:
6 "Divergence in intent for common mobile desktop queries."

7 Do you see that?

8 A. Yes.

9 Q. And this is going to flop over to the next page:
10 "This group is probably the most interesting slice, because
11 mobile users sometimes have different intents, even for the
12 same queries."

13 And that's what you were talking about, right?

14 A. That's right.

15 Q. And I think doing the math you said it was 6 percent
16 on one and 6 percent on the other, right? Is that what -- I
17 didn't -- that's not in the document, I didn't --

18 A. Well, I was referring to this other chart here,
19 actually, that I got the number slightly off. But you see the
20 desktop-dominant, mobile-dominant and the mixture queries,
21 which occur sort of with the same frequency, that was roughly
22 the 66 --

23 Q. Okay, so --

24 A. -- 86, this is what I was referring to.

25 Q. And you got there before me so I couldn't tell you,

1 we're not really supposed to say those numbers, but okay.

2 So those indicate -- I'm not going to repeat them, but
3 those numbers indicate which ones are desktop-dominant, which
4 ones are mobile-dominant, that are the same types of queries
5 but people have a desktop or mobile interest in those, right?

6 A. No. The way to think about this is these are queries
7 that occur both on desktop and mobile, because most queries
8 occur both on desktop and mobile. But these are queries where
9 the number of -- the relative amount of queries on -- the
10 distribution on mobile is higher for these queries, for the
11 mobile-dominant queries, than on desktop; that is, the fraction
12 of occurrence of these queries on desktop is lower.

13 Q. Oh, so that's all you were saying. You were talking
14 about the percentage -- frequency of these queries?

15 A. That's roughly what this is saying.

16 Q. No, but earlier in your -- when you were testifying
17 when Google was asking you questions, when you talked about
18 this, you talked about a 6 percent and a 6 percent. Is that
19 what you were talking about?

20 A. That's what I was talking about.

21 Q. I see, okay.

22 A. I might have been confused a little.

23 Q. No, I --

24 A. This is what -- I was referring to this particular
25 table.

1 Q. Okay, I misunderstood. I appreciate that, sir.

2 Now, it's important for Google or any general search
3 engine to get it right and to know which -- for those ones that
4 are overlapped, the ones where it's the same term but it means
5 it did something different on mobile and desktop, it's
6 important that a general search engine can get that right,
7 correct?

8 A. I mean, it's, again, important on the borders. If you
9 think about it, suppose you get it wrong, right. So suppose
10 you use -- let's say on mobile, let's go back to the Bank of
11 America case, right. And you didn't get it that users were
12 looking for the map, the locations of ATMs, and you use --
13 essentially use the desktop model. Then you'd have shown the
14 Bank of America home page at the top, and then you'd have shown
15 the map. From an overall user perspective, it's not that big a
16 loss. You scroll a little bit and you get the map that you're
17 looking for.

18 So -- but on the borders, we would, of course, prefer to
19 show the map first because we want to optimize it. My only
20 point is if we don't optimize it, it's not that big a loss,
21 because users can still get to the information they're looking
22 for with a little scrolling.

23 Q. Do you know if that secondary information would be on
24 the main screen when they pulled it up on their phone?

25 A. I don't know whether it would be on -- like, if it

1 went the other way, if the map was much larger, if we took the
2 mobile model and brought it to -- well, the desktop, of course,
3 is bigger. So it will depend on the specifics of the details.
4 Sometimes it might be on the second screen or whatever. That
5 will depend on the specifics of it. But a little bit of
6 scrolling will get them where they want. We, of course, would
7 like it to be as optimal as possible, so I don't want to
8 minimize that. But in the scheme of things, it's not as if
9 users won't be served with the slightly less optimal solution.

10 Q. Now, beyond the difference between desktop and mobile,
11 people in different locales could have the different intent
12 with the same search term, right?

13 A. So this was your football example, for example, yes.

14 Q. Or even more specifically -- and I'm talking here now,
15 we're looking at the document. We're at page X1723 at the
16 bottom. It says, in the first example, bracket Norton Pub:
17 "Desktop users meant Norton Publishing Company, whereas mobile
18 users wanted to find a pub named Norton"?

19 A. Yes.

20 Q. And then farther down it says: "For example, in
21 mobile navboost."

22 So Google has a specific navboost for mobile; is that
23 right?

24 A. It's one of the slices, yes.

25 Q. That's the mobile slice?

1 A. Yes.

2 Q. And that's also true on user data, right?

3 A. Yes, yes, it is navboost.

4 Q. "For example, in mobile navboost, the top and third
5 clicked results for Norton Pub are about a pub in Rochester,
6 New York. For people in Rochester, the recommended result
7 looks good, but people not in the Rochester, New York, area are
8 not likely to be satisfied with this. People outside Rochester
9 would want other Norton Pubs in their regions, if any, or
10 prefer the Norton Publishing site, even, when searching on a
11 mobile phone."

12 Do you see that?

13 A. I followed everything you said, but I wasn't sure --

14 Q. Oh, I'm sorry, it was at the bottom of 1723 and the
15 top of 1724.

16 A. Oh, I see it here. Yes, yes, okay.

17 Q. And the whole point is beyond just different countries
18 and different meanings of terms, actually localized data of
19 whether I'm in Rochester, New York or Southern California, what
20 I mean when I'm searching for Norton Pub may be completely
21 different?

22 A. That is true.

23 Q. Now, you talked about the importance of evaluation as
24 part of the search product development?

25 A. If I can go back to your question for --

1 Q. Sure.

2 A. -- just a moment.

3 Q. Please.

4 A. I think you're absolutely right that location matters,
5 and this was the point I was making: That when you're in
6 Rochester, New York, right, we need some way to, in that case,
7 retrieve the Norton Pub document. So we have a whole bunch of
8 techniques to retrieve businesses close to your particular
9 location so that users can get served. Remember, you get
10 navboost only after they're retrieved in the first place.

11 Q. You're saying that's sort of the first culling of
12 documents?

13 A. It's in the first culling of documents, is you make
14 sure that you get these local documents coming in, and then you
15 present them to the user and they can interact with it and
16 create navboost and so forth.

17 Q. Is one of the things that's helpful for Google when
18 local storekeepers go on their website and, like, update the
19 times that they're open and stuff like that, provide that kind
20 of information?

21 A. I mean, that is a useful thing for a user, certainly.
22 I'm not sure what your question actually is referring to.

23 Q. Well, actually, I'll come back to that.

24 So I was turning to the evaluation. Evaluation is a
25 critical part of the search product development; is that right?

1 A. Yes, it is.

2 Q. And you talked about the IS score on your direct exam?

3 A. Yes, I did.

4 Q. And that score is computed from rater rankings, right?

5 A. Yes, it is.

6 Q. So that's always a human metric?

7 A. Yes, it is.

8 Q. And I think we had a demonstrative that I wanted to
9 ask you about. If we could go to DXD17.003.

10 A. Which folder is this in?

11 Q. I'm sorry, this is in -- it's in the black binder, the
12 slides.

13 A. This one?

14 Q. Yes, sir. Thank you.

15 A. What was it, 17?

16 Q. It should be the second page in there, sir, 17.003.

17 A. Yeah.

18 Q. The "regularly test search quality," do you see that?

19 A. Yes.

20 Q. And I think you said you had 16,000 human testers
21 around the world; is that right?

22 A. That is correct.

23 Q. I'm just trying to understand some of these numbers.
24 The blue bar, let's say from 2020, human rater quality tests,
25 what qualifies as a human rater quality test?

1 **A.** So we have query sets created in various ways as
2 samples of our query stream where we have results that have
3 been rated by raters. And we use this -- these query sets as a
4 way of rapidly experimenting with any ranking change.

5 **Q.** I think we should capture that just so we understand.
6 So what you do is you have a query set, and it may be -- how
7 many are in a query set?

8 **A.** It depends on the particular query set.

9 **Q.** Are we talking dozens or hundreds, just so I can get
10 the --

11 **A.** No, let's say 15,000.

12 **Q.** Okay, 15,000. And so you run this through the system,
13 and you get output that you then have human raters look at,
14 right?

15 **A.** Yeah, so these are constantly running in general, so
16 raters have already given ratings for some of them. You might
17 run an experiment that brings up additional results, and then
18 you'd get those rated.

19 **Q.** Okay. So you have basically a place where you have
20 put the past evaluations of these 15,000 queries, put them into
21 a box?

22 **A.** Yeah.

23 **Q.** And then if you've got an engineer here who is very
24 interested about this experiment or that experiment, they do
25 that experiment by looking at some of these experiments that

1 you've already put in the box?

2 **A.** No, we haven't put the experiments in the box. Maybe
3 I misunderstood what the box was.

4 **Q.** I just want to make sure I understand what the 757,000
5 is. This doesn't mean 757,000 times you've organized groups of
6 people to look at output, right?

7 **A.** No. What -- so here's the thing: Let's say we have a
8 query set of let's say 15,000 queries, all right.

9 **Q.** Yes.

10 **A.** We look at all the results for these 15,000 queries.

11 **Q.** Okay.

12 **A.** And we get them rated by our raters.

13 **Q.** So human raters are looking at these?

14 **A.** At all of them, and they provide ratings. So you get
15 an IS score for the query set as a whole.

16 **Q.** For the set?

17 **A.** Yeah, you get an IS score for that. Then along comes
18 an engineer, and they've got a clever idea for improving
19 ranking.

20 **Q.** Right.

21 **A.** So they implement their change. And they come to this
22 query set, and they run this query set through that change and
23 get a different set of results -- or maybe the same set of
24 results in a different ordering.

25 **Q.** I see.

1 **A.** They've got something going. Now, of this, many of
2 the results that they produce we already have ratings from the
3 past, right. And there will be some results that they won't
4 have ratings on. So we'll send those to raters to say tell us
5 about this. So now all the results have ratings again, and so
6 we'll get an IS score for the experimental set.

7 **Q.** So this number, 616,386, these are not unique
8 experiments where the entire 15,000 set is ranked and scored
9 again?

10 **A.** They're ranked -- not by raters, because there's a lot
11 of overlap. Changes don't change everything, right. That
12 wouldn't be a very good situation to have, right. So most
13 changes change a few results. Maybe they change the ordering
14 of results, in which case you don't even have to get new
15 ratings, or sometimes they add new results and you get ratings
16 for those. So it's a very powerful way of being able to
17 iterate rapidly on experimental changes.

18 **Q.** Okay. So now --

19 **A.** That's why there are so many of them.

20 **Q.** And I didn't mean to interrupt. I apologize, sir.

21 So now let's talk about the human raters side-by-side.
22 Those are ones where people actually get the two, the old and
23 the one being tested side-by-side, and human beings have to
24 actually score every single one of those --

25 **A.** That is correct.

1 Q. -- to figure out?

2 A. That is correct, which is why there are many fewer of
3 those, because that's a slower process.

4 Q. But when you decide to do it, you decide -- Google
5 decides to invest money in having that --

6 A. Yes --

7 Q. -- process done?

8 A. -- absolutely.

9 THE COURT: Sorry to interrupt, but just help me
10 understand what the unit is here. In other words, 616,386
11 what?

12 THE WITNESS: Experiments.

13 THE COURT: Those are individual experiments?

14 THE WITNESS: Individual experiments. Because they're
15 easy to run, people tend to run a lot of them.

16 THE COURT: I see. These are just --

17 THE WITNESS: You just run it on your machine, you get a
18 new ranking. Usually, it doesn't require any or very little
19 additional human rater information. So it allows a very rapid
20 back and forth between trying an idea and seeing whether it's
21 any good. That's why there are so many of them here.

22 THE COURT: I see. And would it be accurate to say that
23 something that falls in this column is less likely to need
24 approval, for example, to run those than something that is a
25 live experiment?

1 **THE WITNESS:** It is true that live experiments require
2 more approval of various sorts. The ones in the blue column
3 require very little or no approval. As a rule, we try to make
4 experimentation as easy as possible, because we want people to
5 experiment. So there is that.

6 **THE COURT:** Gotcha, okay. Thank you.

7 **BY MR. DINTZER:**

8 **Q.** So IS is Google's primary top level measure of
9 quality, right?

10 **A.** Yes.

11 **Q.** And sometimes IS-scored documents are fed -- used to
12 train the different modules, models in Google search stack,
13 right?

14 **A.** Yes.

15 **Q.** And sometimes -- and -- but IS rating has different
16 pros and cons compared to using click data to train those same
17 systems, right?

18 **A.** Yes.

19 **Q.** One advantage of click data has over IS data is clicks
20 give a measure of the actual user performance?

21 **A.** That is correct.

22 **Q.** So if I want to know how to hang a 500-pound picture
23 and I've had some experience doing that before, when I'm
24 looking at the search results, I bring that knowledge to it,
25 whereas the human rater is looking at something, and they may

1 not know how to evaluate those search results?

2 **A.** That is correct. But what we ask the human raters to
3 do is to put themselves in the shoes of the typical user that
4 might be there, because the raters are a representation of the
5 users. And most users maybe are unlikely to have had the
6 experience of hanging a 500-pound piece of art, and so they
7 might actually be interested in understanding the steps.
8 Certainly, an expert user who knows all about how to do this
9 may not find those results as compelling because they might be
10 looking for something more advanced. That is certainly true,
11 because none of this talks about personalizing results to a
12 particular user. But raters are supposed to be a
13 representation of what users -- your general user is looking
14 for.

15 **Q.** But users have a better sense of what they intend when
16 they issue the query than a rater can possibly have?

17 **A.** That is -- every user clearly comes with an intent,
18 which you can only hope to guess.

19 **Q.** So IS data is more coarse than search results; is that
20 correct?

21 **A.** Is more coarse than?

22 **Q.** Yes.

23 **A.** Than what?

24 **Q.** Search results.

25 **A.** IS data is actually rating of search results, so I'm

1 not sure I --

2 Q. Let me try --

3 A. -- quite understood --

4 Q. I'll come back to that one, that's fair. That's a --
5 I need to come back to that.

6 Now, for the longest time, Google didn't use a lot of --
7 where are we -- oh, there we go, a lot of machine learning; is
8 that right?

9 A. For a lot of time?

10 Q. For a long time, up until -- up until what year did
11 Google start using machine learning?

12 A. So it depends on what we mean by machine learning.
13 Certainly, for deep learning -- which is what we talked about
14 at length this morning, we started using deep learning in 2015.
15 But other forms of machine learning, things like decision trees
16 and other methods for machine learning, we had started using
17 earlier.

18 Q. And you believe that the core systems and the machine
19 learning systems, that they're complementary, right?

20 A. I mean, in some ways they can also refer to -- point
21 in the same direction. They're not necessarily complementary.
22 They're additive, certainly.

23 Q. And they all contribute in different ways to the final
24 ranking score?

25 A. Yes, that is true.

1 Q. The main three deep learning models Google uses in
2 ranking are RankBrain; is that right?

3 A. Yes.

4 Q. DeepRank?

5 A. Yes.

6 Q. And RankEmbed BERT, right?

7 A. Yes, yes.

8 Q. These three deep learning models are trained in part
9 on click and query data; is that right?

10 A. That is correct.

11 Q. So let's start with RankBrain. RankBrain looks at the
12 top 20 or 30 documents and may adjust their initial score; is
13 that right?

14 A. That is correct.

15 Q. And RankBrain is an expensive process to run?

16 A. It's certainly more expensive than some of our other
17 ranking components.

18 Q. So that's, in part, one of the reasons why you just
19 wait until you're down to the final 20 or 30 before you run
20 RankBrain?

21 A. That is correct.

22 Q. RankBrain is too expensive to run on hundreds or
23 thousands of results?

24 A. That is correct.

25 Q. RankBrain is trained on queries across all languages

1 and locales Google operates in?

2 A. I think so, yes.

3 Q. And then it's fine-tuned on IS data?

4 A. That is correct.

5 Q. But it is not possible to train RankBrain on only
6 human rater data, right?

7 A. No, you can't.

8 Q. And each time RankBrain is retrained, it is with fresh
9 data, right?

10 A. It's with -- yes, with new data, yeah.

11 Q. And for years, RankBrain was trained on 13 months
12 worth of click and query data; is that right?

13 A. I think initially it started with the same amount as
14 navboost, yes.

15 Q. And now --

16 MR. SMURZYNSKI: Your Honor, if I could just -- a number
17 of these months, days and what, we've already deliberately put
18 in redacted boxes in the exam we did this morning. So I'd just
19 caution.

20 MR. DINTZER: No, no, I appreciate -- it's easier when I'm
21 looking at a document. I will make an effort. I understand.

22 Q. Now, RankBrain needs to be trained at a regular
23 cadence, because otherwise it would be blind to new events,
24 right?

25 A. That certainly is a factor, yes.

1 Q. Now, you discussed DeepRank in your testimony; is that
2 right?

3 A. Yes, I did.

4 Q. And you also discussed BERT, right?

5 A. Yes.

6 Q. And an application of BERT, when BERT is used for
7 ranking, is DeepRank, right?

8 A. Yes.

9 Q. And so, I mean, it's not BERT, but it is -- it's from
10 BERT. When BERT is used for ranking, that's DeepRank?

11 A. That's correct.

12 Q. And DeepRank is trained on user data?

13 A. Yes, it is.

14 Q. Let's go to UPX860.

15 **THE COURT:** Can I interject with a question. When you
16 talk about a number of months of user data, can you tell me
17 what that means? Are we talking about quite literally all of
18 the data that Google has collected over 13 months or is it
19 something else?

20 **THE WITNESS:** It's the queries and the clicks that
21 occurred over that period of time.

22 **THE COURT:** From all users?

23 **THE WITNESS:** From all users. You might train the model
24 on only some subset of the users, such as, say, U.S. users if
25 you're launching just a U.S. model. But to the extent that

1 you're launching a global model, it will look at all users,
2 yes.

3 **THE COURT:** Understood, thank you.

4 **BY MR. DINTZER:**

5 **Q.** The thing about -- I'm just going to jump off of that
6 question. When you think about months of data -- so if we
7 think about sort of the unit of a month, Google -- a month of
8 data today is not the exact same measurement as a month of data
9 three years ago, right?

10 **A.** It's not exactly the same, no.

11 **Q.** Because as Google's usage has gone up, that same month
12 will have more clicks and queries in it, right?

13 **A.** It will have somewhat more clicks and queries, yes.

14 **Q.** So if we measured -- if we compared a month of Google
15 data and a month of Bing data -- I'm not going to ask you for
16 the multiple, I'm going to provide it as just a hypothetical.
17 Let's just say, hypothetically, Google had seven times as many
18 clicks and queries as Google in a given month. That month of
19 data for Google is seven times bigger than the month of data
20 for Bing, because it's not an absolute measurement, it's just
21 how much was gathered in that month, right?

22 **A.** If that number is correct, then yes.

23 **Q.** I just wanted to get -- because we're talking about
24 months, but in reality we're talking about -- what's the
25 measure when you get to this volume? Is it -- it's not

1 terabytes, it's --

2 A. I don't know what the number is.

3 Q. Anyways, it's off the charts. But it's not the same
4 for each general search engine, right?

5 A. That is true.

6 Q. So we were on UPX860. You're familiar with this
7 document, sir; is that right?

8 A. I don't know. I mean, I may have seen it, but --

9 Q. Apparently this was a presentation -- I can show you
10 the cover -- this was a presentation made in 2019?

11 A. Okay.

12 Q. Okay. So let's go to...

13 MR. DINTZER: We'll offer this, Your Honor. My notes are
14 shy here, so it's unclear whether it's in, but we'll offer.

15 MR. SMURZYNSKI: We have no objection.

16 THE COURT: So UPX860 will be admitted, if it's not
17 already.

18 (Exhibit UPX860 admitted into evidence)

19 MR. DINTZER: Thank you, Your Honor.

20 Q. So this is a 2019 review, and we talked about
21 DeepRank. And so let's go to 4417, at the bottom; it's slide
22 eight. It says: "Serving DeepRank at the top."

23 Do you see that?

24 A. Yes.

25 Q. And we've kept the numbers off, so we're not going to

1 say the numbers. It says -- the second bullet -- the first
2 bullet under the second black bullet, it says: "RankBrain
3 understands long-tail user need as it trains on" -- and I can't
4 say the number, but it's not an actual number, it's a greater
5 than number.

6 Do you see that?

7 A. Yes, I do.

8 Q. Of data, okay. So -- and when it says "trains on,"
9 that means that data is used to train the system; is that
10 right?

11 A. Yes.

12 Q. And then it says: "DeepRank understands language and
13 has common-sense."

14 Do you see that?

15 A. Yes.

16 Q. And those are two different things. The ranking part
17 and the understanding language part, those are two separate
18 things, right?

19 A. The understanding language leads to ranking. So
20 DeepRank does ranking also.

21 Q. But they are related, but they're not -- this is
22 referring to them as separate items, correct?

23 A. I mean, both RankBrain and DeepRank do ranking, so I'm
24 not sure that they're separate items. So maybe you're talking
25 about something else.

1 Q. So let's go to the next -- the black bullet.

2 THE COURT: I'm sorry, the number that's in the box that
3 you just testified about, that is a magnitude relative to what?

4 THE WITNESS: So I don't actually recognize this number.
5 And certainly, in its current usage, it's more like 2X or some
6 small number of X. So I don't recognize the number in here,
7 but that's what it says here, so I'll take it.

8 BY MR. DINTZER:

9 Q. And at the top there -- of that bullet it says: "Does
10 DeepRank replace RankBrain? No, complementary strengths."

11 Do you see that?

12 A. Yes.

13 Q. And you agree with that?

14 A. Yeah, I mean, I think that's not an unreasonable
15 position, though over time they are becoming less
16 complementary. At the time that this was done, maybe they were
17 more complementary, but DeepRank is taking on more and more of
18 that capability now.

19 Q. The next black bullet there says: "Are we turning
20 ranking entirely over to deep learning?"

21 And the answer, I think you said the same thing today, is
22 no?

23 A. Yeah.

24 Q. And the reason explains is: "Still a black box,
25 various protections to limit model."

1 Do you see that?

2 A. Yes.

3 Q. And the deep learning was a black box back then, and
4 Google didn't want to trust it with all of its analysis,
5 correct?

6 A. I think it's risky for Google -- or for anyone else,
7 for that matter, to turn over everything to a system like these
8 deep learning systems as an end-to-end top level function. I
9 think it makes it very hard to control.

10 Q. And then the next point is: "Deep learning still
11 doesn't scale as well as traditional data mining."

12 Do you see that?

13 A. Yes.

14 Q. And traditional data mining, that's click query data,
15 right?

16 A. I don't know exactly what is meant there. I think of
17 data mining as looking at data and extracting insights that you
18 might use in certain ways. So the way we used to traditionally
19 build ranking systems was looking at data to carefully craft
20 ranking functions. I would call that data mining also. So I'm
21 not sure exactly what is meant in this document here.

22 Q. But what you're describing is navboost, right?

23 A. No, no, no. Navboost could be one thing, but even the
24 careful ranking functions that we created as a form of data
25 mining where we looked at data to figure out like how can we

1 generalize what we are seeing, the data need not be a lot of
2 data. It could be a small amount of data. You're trying to
3 extract insights that allow you to generalize. So data mining
4 is a very broad term in that sense.

5 Q. Okay. No further questions on that document, sir. If
6 you could go to DX134.

7 A. Is that in --

8 Q. That's in the binder that the defendants gave you.
9 It's the zero to BERT document.

10 A. Yeah.

11 Q. And let's go to Page 5213. Just let me know when
12 you're there.

13 A. Yeah.

14 MR. DINTZER: And can I say this one? I will check with
15 counsel, because --

16 MR. SMURZYNSKI: You can proceed on this one, yes.

17 BY MR. DINTZER:

18 Q. Okay. The second bullet here says -- under the
19 heading of "training," it says: "We can potentially do even
20 better by pre-training on our own task-specific large corpus."

21 Do you see that?

22 A. Yes.

23 Q. "User feedback at the core of most search systems."
24 Do you see that?

25 A. Yes, I see that.

1 Q. When it says user feedback, that's click data, right?

2 A. That is correct.

3 Q. And then if we can go to page 5231 of this document.

4 Just let me know when you're there.

5 A. Yes.

6 Q. And it says "BERT limitations." So you talked about

7 BERT with the Court, right?

8 A. Excuse me?

9 Q. You talked about BERT with the Court?

10 A. Yes, I did.

11 Q. And this page has some of BERT's limitations. I hate
12 to down-talk the old guy, but -- so the third bullet here says:
13 "Does not subsume big memorization systems, navboost, QBST, et
14 cetera."

15 Do you see that?

16 A. Yes, I do.

17 Q. And that's accurate, right?

18 A. I mean, it does not subsume memorization, no.

19 Q. And then we go to 5233. And let me know when you're
20 there.

21 A. Yes.

22 Q. And it says -- at the second bullet it says -- the
23 heading is: "Rapid progress is straining evaluation."

24 Do you see that?

25 A. Yes.

1 Q. "Performance that rocks metrics may not impress
2 users." And then under that it says: "Users may have hours to
3 years of experience on a query topic. Raters have only a few
4 minutes to grasp the topic."

5 Do you see that?

6 A. Yes, I do.

7 Q. And that touches on one of the things we talked about,
8 how humans working as actual users evaluate results in a
9 different way than human raters, right?

10 A. They definitely do. I mean, they have different
11 context, yes.

12 Q. And so even a system that scores high on an IS, that
13 might not translate to actual quality for the actual users,
14 correct?

15 A. It might not.

16 Q. No further questions on that document.

17 A. And yet I will say it seems to. This is what the
18 growth experiments showed, that people actually like
19 improvements in IS and they use search more. Specific users
20 may not be satisfied by the IS improvement, absolutely. But in
21 aggregate, it appears that IS is well correlated with
22 helpfulness to users at large.

23 Q. And when you say in the aggregate, that means across
24 the entire corpus of Google users, correct?

25 A. Across the corpus of Google users, yes.

1 Q. Let's go to UPX2029.

2 A. Is that in --

3 Q. That is in the binder that we have given you. Just
4 let me know when you're there, sir.

5 A. Yes, I am.

6 MR. DINTZER: Your Honor, we'll offer this.

7 THE WITNESS: Excuse me?

8 MR. DINTZER: I'm sorry, just one second.

9 THE COURT: That was directed to me.

10 MR. DINTZER: That's not a question for you, sir.

11 THE COURT: Any objection, counsel?

12 MR. SMURZYNSKI: It's just going to take me a second,
13 because we got this last night at 10:00 o'clock. But I think
14 it's --

15 MR. DINTZER: We can go ahead, Your Honor, and we can jump
16 back to them afterwards, if that's okay with the Court.

17 MR. SMURZYNSKI: We have no objection.

18 THE COURT: Okay, terrific. Thank you, counsel.

19 BY MR. DINTZER:

20 Q. So what is this document, sir? Do you recognize it?

21 A. It looks like a ranking newsletter.

22 Q. And is this something you would see in the normal
23 course?

24 A. Yes, I would.

25 Q. And let's go to the second page of it, 8074.

1 A. Yes.

2 Q. And the heading is: Why DeepRank?

3 Do you see that?

4 A. Yes, I do.

5 Q. And it says: "We started using deep learning and web
6 ranking several years ago, first in the form of RankBrain and
7 then RankEmbed. DeepRank is the latest edition to this family
8 of systems."

9 Do you see that?

10 A. Yes, I do.

11 Q. And these are machine learning systems, the ones we've
12 talked about, right?

13 A. Yes.

14 Q. And then it says -- a little bit farther down in the
15 middle of the next paragraph -- actually, let's stay there.
16 The next sentence says: "DeepRank not only gives significant
17 relevance gains, but also ties ranking more tightly to the
18 broader field of language understanding."

19 Do you see that?

20 A. Yes, I do.

21 Q. Go down to the middle paragraph in the next -- the
22 middle of the paragraph. It says: "Effective ranking seems to
23 require some amount of language understanding paired with as
24 much world knowledge as possible."

25 Do you see that?

1 A. I'm not sure I see it. I believe what you said --

2 Q. No, of course, and it's right in the middle of that --
3 the second paragraph under "Why DeepRank?"

4 A. Oh, yes, I see it. Yes.

5 Q. So to rank organic links, the system needs both
6 language understanding and world knowledge?

7 A. Yes.

8 Q. And DeepRank does the language understanding, right?

9 A. Well, I mean, it's -- that's probably an
10 oversimplification. I suspect it also has world knowledge
11 built into it.

12 Q. You don't know?

13 A. I mean, this is what the network learned. This is
14 part of --

15 Q. The black box?

16 A. Exactly. So it's learned something about language
17 understanding, and I'm confident it learned something about
18 world knowledge, but I would be hard-pressed to give you a
19 crisp statement on these. These are sort of inferred kind of
20 things.

21 Q. Let's go farther down. The paragraph that begins "in
22 general," do you see that?

23 A. Yes.

24 Q. "In general, effective language understanding seems to
25 require deep computation and a modest amount of data."

1 Do you agree with that sentence?

2 A. Yeah, for some definition of modest, I suppose.

3 Q. The next part is: "In contrast, world knowledge is
4 all about data; the more the better."

5 Do you see that?

6 A. I see that, yes.

7 Q. World knowledge part of ranking requires data, right?

8 A. Yes.

9 Q. No further questions on that document, sir.

10 THE COURT: I'm sorry, in this context, what does "world
11 knowledge" mean in this context?

12 THE WITNESS: That's a very good question. One of the
13 interesting things is you get a lot of world knowledge from the
14 web. And today, with these large language models that are
15 trained on the web -- you've seen ChatGPT, Bard and so forth,
16 they have a lot of world knowledge because they're trained on
17 the web. So you need that data. They know all kinds of
18 specific facts about it. But you need something like this.

19 In search, you can get the world knowledge because you
20 have an index and you retrieve documents, and those documents
21 that you retrieve gives you world knowledge as to what's going
22 on. But world knowledge is deep and complicated and complex,
23 and so that's -- you need some way to get at that.

24 BY MR. DINTZER:

25 Q. We'll come back to this, but Bard is not part of

1 Google's search systems, right?

2 A. Bard is not part of Google's search systems, no.

3 Q. And am I right that for launches, Google combines
4 different sources of data to make an informed decision about
5 whether to go forward?

6 A. Yes, that's correct.

7 Q. And these data come from human evaluations, live
8 traffic -- and live traffic studies; is that right?

9 A. That, and together with things like capacity and cost
10 and those types of things. And complexity, we look at that,
11 too.

12 Q. And I think -- did you say cost?

13 A. The expense of running these things in terms of
14 latency and those types of factors.

15 Q. But also just the cost of paying for whatever the
16 system is that --

17 A. We think of it as capacity. We don't think in terms
18 of cost per se. We have a certain capacity. We have a certain
19 latency budget. We want to keep it within all of those things.

20 Q. Okay. So your capacity budget is dollar constrained,
21 though, correct?

22 A. I'm sure there is some constraint of that sort.

23 Q. So still on UPX2029, I just have one more set of
24 questions, sir. We're at page 8075.

25 A. Yeah.

1 Q. It has a bullet: DeepRank.

2 Do you see that?

3 A. Yes.

4 Q. And in the middle of that paragraph it says:

5 "Training is also more computationally expensive."

6 Do you see that?

7 A. Yes.

8 Q. What does that mean, computationally expensive?

9 A. So training -- so DeepRank is this bold model which
10 uses these transformers which looks at the sequences of things.
11 And it needs to look at -- it turns out training transformer
12 models is more expensive than training straightforward
13 feedforward networks like Google Brain or RankBrain. Those are
14 cheaper to train. And so you need -- it's more expensive in
15 that sense, more computation is required. Because, in a sense,
16 it's solving a harder problem.

17 Q. And then the next paragraph begins: "Consequently,
18 DeepRank seems to have the capacity to learn the understanding
19 of language and common-sense that raters rely on to guesstimate
20 relevance, but not nearly enough capacity to learn the vast
21 amount of world knowledge needed to completely encode user
22 preferences."

23 Do you see that?

24 A. I see that, yes.

25 Q. And because of the cost of training DeepRank, it

1 doesn't have the deep world knowledge element that we've been
2 talking about; is that right?

3 A. That's what this is implying. Whether it could or not
4 is a separate question. Whether, in fact, if you just trained
5 on logs you could do this. But after all, the same kinds of
6 transformer-based models today are being trained for ChatGPT,
7 for Bard, for SGE and so forth, on web data to give them the
8 world knowledge. So I don't think this is a claim about
9 whether it's possible or not here.

10 Q. Right, it's just talking about the expense?

11 A. To the extent that we could use it, yes.

12 Q. Another deep learning system Google uses in search is
13 called the RankEmbed BERT. We've got that one there. That one
14 doesn't roll off the tongue.

15 A. Well, it's RankEmbed that was augmented to use the
16 BERT algorithm, the BERT structure, that's what it is.
17 RankEmbed was launched earlier without BERT. RankEmbed BERT
18 augmented it with BERT so it was even better at understanding
19 the language.

20 Q. And I'm not going to say the percentage, because I
21 think that those are off limits, but RankEmbed BERT is trained
22 on click and query data, right?

23 A. Yes, it is.

24 Q. And then it's fine-tuned on human IS rater data?

25 A. Yes, it is.

1 Q. And it needs to be retrained so that the training data
2 reflects the fresh events?

3 A. Yes.

4 Q. Getting back to, you know, we talked about this idea
5 that a month of Google data is different than a month of Bing
6 data. If Google had a smaller amount of data per month, and it
7 had to use more months to train its machine language so that it
8 kept the amount of data that it was getting constant, that
9 would be less fresh, right, because you would have to have more
10 months of data to train them on?

11 A. I mean, that's not immediately clear, because as long
12 as you have the data from the freshest month, you get a taste
13 for that fresh data. Whether that's enough or not is an
14 empirical question.

15 Q. You don't know the answer to that question?

16 A. I don't know the answer to that question.

17 Q. But the quality of RankEmbed BERT can slowly start to
18 go down if you're not retraining it with fresh data; is that
19 right?

20 A. Just going back to that previous question, it's worth
21 noting that when we trained RankEmbed BERT, we'd take a small
22 fraction of the traffic. So that's an example of where you
23 don't need all of those -- whatever the days of data that
24 was -- that DeepRank used, it took some small fraction of that
25 traffic. So having some exposure to the fresh data is actually

1 quite valuable, which is why I'm saying it's an empirical
2 question as to whether it is enough or not.

3 Q. Okay.

4 A. And not one that I can blanket make a statement about.

5 Q. All things being equal, though, more -- data that is
6 fresher is more valuable than data that is older?

7 A. Not always the case, as we've discussed in the case of
8 the turkey recipe. The fresh data may not be the best data, so
9 all things in that sense are rarely equal.

10 Q. Okay. User data, click and query data, fresher user
11 click and query data is typically more valuable than older
12 click and query data, correct?

13 A. Again, it depends on the query, and it depends on this
14 thing -- there are situations where the older data is actually
15 more valuable. So I think these are all sort of empirical
16 questions to say, well, what exactly is happening. There are
17 clearly situations where fresh data is better, but there are
18 also cases where the older data is more valuable.

19 Q. Does Google have a way of measuring how valuable the
20 older data is?

21 A. We have not explicitly measured that.

22 Q. Traditional systems work by looking up documents in
23 the index, like you would use an index in the back of a book;
24 is that right?

25 A. That is correct.

1 Q. The core ranking algorithms retrieve most of the
2 documents that will be scored?

3 A. Yes.

4 Q. RankEmbed identifies a few more documents to add those
5 identified by the traditional retrieval?

6 A. That is correct, for some definition of few.

7 Q. You talked about MUM; is that right?

8 A. That is correct.

9 Q. If we could go to UPX2034. This is something you
10 wrote in 2021; is that right?

11 A. Just a moment.

12 Q. Oh, please, take your time.

13 A. Ah, yes.

14 Q. So this is a blog post you wrote; is that right?

15 A. Yes.

16 Q. And this is about MUM, right?

17 A. Yes, it is.

18 Q. And if we could go to the third page of this, of
19 UPX...

20 **MR. DINTZER:** Oh, well, we'll offer it. This is from
21 Google's website.

22 **MR. SMURZYNSKI:** No objection.

23 **THE COURT:** Okay, it will be admitted.

24 (Exhibit UPX2034 admitted into evidence)

25 **BY MR. DINTZER:**

1 Q. At the top of the third page you write: "Training and
2 running advanced AI models can be energy consumptive"?

3 A. Yes.

4 Q. That's because there's a lot of computation going on
5 there, right?

6 A. Yes.

7 Q. And that can be expensive?

8 A. Yes.

9 Q. And then you write: "Another benefit of training
10 smaller application-specific models is that the energy costs of
11 the larger base model, such as MUM, are amortized over many
12 other different applications."

13 Do you see that?

14 A. That is correct.

15 Q. And running the AI model, such as MUM, can be more
16 expensive than the core models that we looked at?

17 A. Yes. I just want to emphasize that the difficulty --
18 I mean, certainly they will be more expensive, no question
19 about that. But the bigger thing is running those bigger
20 models at the latency that you need and the throughput that you
21 need is very, very hard. Running things at such scale to get
22 sub second latencies, to get them at the QPS that we need to
23 run it, is very, very difficult. It's not just that it's
24 expensive.

25 Q. Okay. When you say those bigger models, you mean like

1 MUM?

2 A. Yes.

3 Q. I just wanted to make sure I understood that.

4 Then two paragraphs farther down it says: "New language
5 models like MUM have enormous potential to transform our
6 ability to understand language and information about the
7 world."

8 A. Yes.

9 Q. "And while they may be powerful, they do not make our
10 existing systems obsolete."

11 You believed that when you wrote it?

12 A. Excuse me?

13 Q. You believed that when you wrote it?

14 A. I believed that when I wrote it, and I still believe
15 it.

16 Q. Okay. "Today, Google search employs hundreds of
17 algorithms and machine learning models, none of which are
18 wholly reliant on any singular large model."

19 And that's still true, right?

20 A. Yes.

21 **MR. DINTZER:** And, Your Honor, I'm going to change gears.
22 This might be a good place.

23 **THE COURT:** Okay. How much longer do you think you have?

24 **MR. DINTZER:** Probably another hour. I'll see what I can
25 do to edit, Your Honor.

1 **THE COURT:** Why don't we take the next 15 minutes to see
2 if that can be --

3 **MR. DINTZER:** Thank you, Your Honor.

4 **THE COURT:** -- trimmed down. Okay, thank you.

5 (Recess taken at 2:55 p.m.)

6 (Back on the record at 3:16 p.m.)

7 **THE COURT:** I'm glad you've applied navboost to your
8 examination.

9 **BY MR. DINTZER:**

10 **Q.** Sir, we're going to go in your book to UPX2026.
11 That's the book we gave you. And it's a very -- it's a big
12 document. We've given you an excerpt of the pages that -- if
13 you feel like you need to look at the whole document, we'll
14 hand it up, but it's like 400 pages. The title of this is
15 "Search Platforms Summit," and then "Welcome."

16 Do you see that?

17 **A.** Yes, I do.

18 **Q.** And what is the Search Platform Summit?

19 **A.** Search platforms is one of the four divisions within
20 the search team. It's a sister organization to the search
21 quality team that I'm part of. This is the summit that they
22 had, presumably for the whole team or maybe some appropriate
23 subset of the team.

24 **MR. DINTZER:** And we'll offer this, Your Honor.

25 **MR. SMURZYNSKI:** So, Your Honor, we have a number of

1 pages. We haven't reviewed the whole document. It appears to
2 be a deck that was produced by Google, and in that case we
3 would not object. But it may be that there's a need for a
4 complete document. It may be that there isn't a need for a
5 complete document. But having just received it, we'd want that
6 opportunity to review it. But with those caveats.

7 **THE COURT:** Okay. So we'll admit this excerpt, subject to
8 the completeness request made by Google's counsel.

9 (Exhibit UPX2026 admitted into evidence)

10 **MR. DINTZER:** And we're giving them a whole one now, Your
11 Honor, so that they have access to it.

12 **Q.** Sir, we're going to go to page -- I think it's the
13 second page that you're seeing here, it's Bates numbered 7122.
14 Just let me know when you get there.

15 **A.** Yes, I got there.

16 **Q.** Okay. And the heading is: "Some queries are really
17 slow."

18 Do you see that?

19 **A.** Yes, I see it.

20 **Q.** And it says the queries, but actually this is about
21 latency, right?

22 **A.** This is about latency, yes.

23 **Q.** And this is the time it takes for Google to answer the
24 queries?

25 **A.** That's -- I think that's what it is, yes.

1 Q. And at the bottom the notes say: "It turns out a
2 bunch of queries are really slow for our users." And then if
3 you jump down it says: "One in four times they get issued, it
4 takes more than X for the user to get the answer."

5 Do you see that?

6 A. Yes, I see that.

7 Q. And is that amount of time, the seconds, longer than
8 Google would want it to be?

9 A. It is indeed.

10 Q. I'm going to go to the next page, 7123. Do you see
11 that?

12 A. Yes, I do.

13 Q. And the heading is: "Bing appears faster."

14 Do you see that?

15 A. Yes.

16 Q. And this is on mobile, right, these are mobile pages?

17 A. At least on the left they look like mobile pages. I
18 assume the right, also, they're mobile pages.

19 Q. And at the top it says: "Bing first result arrives
20 sooner X percent of the time."

21 Do you see that?

22 A. Yes, I see that.

23 Q. And what we're seeing here is Google loading a
24 document and then Bing loading the same document, and the
25 comparison of how fast Bing is loading it versus Google. Do

1 you see that?

2 **A.** Yes, I think so.

3 **Q.** And then if we go to the next page, 7124, and the
4 heading is: "Deja vu."

5 Right, do you see that?

6 **A.** Yes.

7 **Q.** And it says: "We haven't been focusing enough on low
8 latency." That's one of the comments. And the footnotes say:
9 "Every couple of years we sound the alarm, have a code yellow,
10 but we keep ending up back here again."

11 Do you see that?

12 **A.** Yes, I do.

13 **Q.** Do you remember when this was an issue that was raised
14 up to you, that Google's latency was significantly slower than
15 Bing's?

16 **A.** I don't remember the specific instance, but this
17 has -- this kind of thing has been raised with me, yes.

18 **Q.** Do you remember Google instituting a response to this
19 specific set of events where Google found that it was slower
20 than Bing on mobile?

21 **A.** Yes. I think we did take action, yes.

22 **MR. DINTZER:** Let's go to UPX2022. And we'll offer this,
23 Your Honor.

24 **MR. SMURZYNSKI:** No objection.

25 **THE COURT:** It will be admitted.

1 (Exhibit UPX2022 admitted into evidence)

2 **BY MR. DINTZER:**

3 Q. Do you recognize this document, sir, Google v. Bing?

4 A. I think I have seen this, yes.

5 Q. And it's a summary of findings. This is June 2017:
6 "Looking specifically at mobile queries on browsers, Bing
7 consistently serves search results faster than Google today."

8 A. Yes.

9 Q. And then number one says: "Bing results arrive
10 approximately 300 milliseconds faster."

11 A. Yes.

12 Q. Do you recall what Project Folly was?

13 A. Folly was an attempt at instituting a set of projects
14 and policies and processes to decrease latency.

15 Q. And with the specific goal of catching Bing on
16 latency?

17 A. Well, I don't know that they made that the specific
18 goal. They would set themselves goals of decreasing latency,
19 and they've consistently done that since then.

20 Q. And what are the elements that cause -- let me try it
21 a different way. How can a company like Bing -- like Google
22 lower latency? And just so that we get the directions right,
23 lower latency is a good thing, right?

24 A. Lower latency is a good thing, yes.

25 Q. So what variables can come into play to lower latency?

1 **A.** I think that there are many, many factors that go into
2 this. So let's start with the -- what's on the search results
3 page. There's been a big push to enrich the search experience,
4 because users like more visual pages with lots of images. And
5 so as there has been a push to have more images on the page,
6 pages have become more heavy. Downloading those images has
7 become more expensive in terms of latency, and that has been a
8 big factor. So finding ways to either compress those images or
9 otherwise cleverly encode them has been some of the work that
10 goes on in decreasing that kind of latency.

11 **Q.** And that would be an investment in engineering and
12 coding and the like?

13 **A.** That is correct.

14 **Q.** And another way of addressing --

15 **A.** And also in process, because it's not as if there is
16 one singular team that does it, it's distributed across many
17 different teams. So you need to make sure that all teams are
18 sort of applying best practices here. So there's process
19 involved also.

20 **Q.** Another way that a general search engine can reduce
21 latency is investment in servers and other hardware, right?

22 **A.** Well, before you get there, there are other factors
23 that go into it, which is as we improve search, such as running
24 ML models and things, the work that you do in constructing the
25 SERP itself goes up. And so there are efficiencies that you

1 need to have in there that allows you to decrease latency also.

2 Q. Okay. And then getting back to my question: The
3 investment in servers and hardware, that can also reduce
4 latency?

5 A. So that may or may not be the case, right. It is true
6 that when servers are heavily loaded, when there are traffic
7 peaks, adding extra machines can reduce latency. Because when
8 servers get heavily loaded, then the requests sort of back up
9 one behind the other, and you have to wait for the previous
10 request to finish before you can start. But typically, other
11 than at very peak times, servers don't run hot, they run at
12 sort of a lower capacity. In those cases, there's plenty of
13 compute, so that's not the problem.

14 Some of these other factors are a problem. The way your
15 software is structured, for example, we have a strategy -- a
16 historical strategy of constructing the whole SERP and then
17 shipping it back. And instead of doing that, you should have
18 more of a streaming strategy that figures out what should be at
19 the top and sends it back while you're still working on the
20 rest of it. So there are lots of things you can do. I think
21 machines -- adding machines is only one thing, and that only
22 addresses one fairly narrow aspect of the problem.

23 Q. Thinking about the machines, also building servers
24 closer to individuals so that there's less travel time between
25 the servers and the individuals, that also can reduce latency?

1 **A.** So you make a good point that the transport layer, the
2 connection between the user and Google, is another factor. And
3 that is affected by things like where Google servers are, but
4 it's also affected by the user's own network connectivity with
5 their ISP, you know, is it over wifi, is it over a mobile
6 network. I guess we don't have dial-up anymore. But the
7 user's own network connectivity sort of factors into this.

8 **Q.** Let's go to the second page of 2022, under the
9 heading, "Background." And it says: "Background. As part of
10 the Folly effort, it was observed that today Bing appears to
11 serve search results faster than Google. In one of the worst
12 cases found, the query 'San Diego to LAX train' takes 3.69
13 seconds for content downloaded on Google versus only 565
14 milliseconds for Bing."

15 Do you see that?

16 **A.** Yes, I do.

17 **Q.** And that was one of the things that was raising
18 concern at Google?

19 **A.** Well, certainly having one query by itself is -- I
20 mean, it's concerning that it should take a long time, but just
21 feels like an outright bug to me more than anything else. I
22 don't know exactly what happened with that query.

23 **Q.** But that's a long time?

24 **A.** But that's a long time.

25 **Q.** I'm sorry, I didn't mean to interrupt.

1 **A.** Go ahead. Go ahead.

2 **Q.** Under the next heading it says -- under 2014 latency
3 lab study it says: "The question has come up before. In 2014
4 latency lab studies, Bing was faster than Google, mainly due to
5 it's lack of SSL."

6 Do you see that?

7 **A.** Yes, I do.

8 **Q.** So the latency issue had been one with respect to Bing
9 for a while?

10 **A.** It was certainly back then in 2014 also.

11 **Q.** And Google invested in engineering and work and time
12 to try to reduce the distance in latency between it and Bing,
13 right?

14 **A.** I think more than thinking about it as Bing, I would
15 say Google invested in reducing its latency.

16 **MR. DINTZER:** And so let's go to 2027. We'll offer, Your
17 Honor.

18 **MR. SMURZYNSKI:** No objection.

19 **THE COURT:** 2027 is admitted.

20 (Exhibit UPX2027 admitted into evidence)

21 **MR. DINTZER:** Thank you.

22 **BY MR. DINTZER:**

23 **Q.** Sir, this is an e-mail chain that you were on from
24 June 19th, 2017; is that right?

25 **A.** Yes, it is.

1 Q. Let's go to the third page under analysis and tools.
2 Do you see that?

3 A. Yeah.

4 Q. And it says: "Google v. Bing comparative analysis.
5 Bing results arrive 300 milliseconds faster."

6 Do you see that?

7 A. Yes.

8 Q. And so that's the same thing that we were talking
9 about, the 300 milliseconds, right?

10 A. I think so.

11 Q. Okay. And then let's go to the first page, and we see
12 an e-mail from Nicholas Lim. And who is Nicholas Lim?

13 A. Honestly, I don't know.

14 Q. Okay. And you'll see that he writes: "Hi, all.
15 Here's the latest Folly search latency update."

16 A. Yes.

17 Q. And the too long, did not read summary says: "The
18 Folly program has defined two explicit goals to tackle head and
19 tail latency, reduce mean latency by 300 milliseconds and
20 reduce terrible" -- I'm not supposed to say that number --
21 "searches from" -- and I'm not supposed to say those numbers.

22 Do you see that?

23 A. Yes.

24 Q. So that happens to be the same 300 milliseconds as the
25 Bing distance, right?

1 **A.** Those numbers are certainly the same, yes.

2 **Q.** Okay, okay. And then it says: "Nine cross-server
3 client product workstreams have been defined to meet these
4 ambitious goals and change culture to maintain latency
5 improvements."

6 Do you see that?

7 **A.** Where is this?

8 **Q.** That's the very next sentence after the TL;DR that I
9 just read.

10 **A.** Oh, yes. Yes.

11 **Q.** So this was an instance when Google -- I mean, this is
12 an investment, cross-server client product workstreams, Google
13 invested a number of people to look at this problem, right?

14 **A.** Yes. But I want to call your attention to the "change
15 culture to maintain latency improvements," because this gets to
16 the heart of why latency goes up. A lot of teams are very
17 focused on quality, not just of things like ranking, but also
18 the user experience. And that's their focus, is to really
19 improve the user experience and so forth. And these teams are
20 not necessarily experts on things like latency. And as we
21 improve the user experience, maybe by adding more images, maybe
22 by doing more work, maybe going to more back ends to build a
23 more comprehensive page, latency goes up.

24 And that's what they're talking about: How do we get a
25 culture change to make sure that all the hard work that this

1 team does to reduce latency isn't eaten up by quality
2 improvements by other teams.

3 Q. Okay. Do you know if Bing ever -- if Google ever
4 caught Bing on latency?

5 A. No, I don't know.

6 Q. Let's go to UPX2033. This is an April 21st, 2020
7 e-mail chain that you're on?

8 A. Yes.

9 MR. DINTZER: We'll offer this, Your Honor.

10 MR. SMURZYNSKI: No objection.

11 THE COURT: It will be admitted.

12 (Exhibit UPX2033 admitted into evidence)

13 BY MR. DINTZER:

14 Q. Who's Mr. Gomes, Benedict Gomes?

15 A. He used to be my boss at that time, I think. He used
16 to be heading search.

17 Q. And he writes at the bottom e-mail -- and this is
18 April 20th -- and just to remind us all, that was sort of right
19 after COVID shutdown. He writes: "Hey, I want to make sure
20 the next COVID update goes over the key priorities as I see
21 them, probably in descending order. We can't obviously cover
22 all of these."

23 Do you see that?

24 A. Yes.

25 Q. And number one was: "Query sets and side-by-sides on

1 key COVID queries."

2 Do you see that?

3 A. Yes, I do.

4 Q. And that was that side-by-side testing that we talked
5 about for COVID queries?

6 A. Yes.

7 Q. And he wanted to do that testing to see how Google was
8 doing?

9 A. Yes.

10 Q. And then you write back and you write: "We do have a
11 good query set where we've done a side-by-side with Bing."

12 Do you see that?

13 A. Yes.

14 Q. So the testing that Google did with respect to Bing on
15 COVID was a side-by-side?

16 A. Well, we've certainly done a side-by-side. I don't
17 know whether that's exactly what he's referring to here, but we
18 clearly did do a side-by-side with Bing, yes.

19 Q. And you write: "Overall, we do very well, but the
20 team is drilling into the loss cases to see what we can
21 improve."

22 Right?

23 A. Yes.

24 Q. And so Google was looking at the times when Bing might
25 have done better than Google?

1 A. Yes.

2 Q. And you talked about how Google looks at Bing for
3 latency and for quality, and that's something that Google has
4 done for the past 10, 12 years, right?

5 A. Yes. But we've also looked at other places where
6 people find information. We've done similar exercises with
7 TikTok, for example.

8 Q. Do you know if there's been a latency test against
9 Google and TikTok?

10 A. No, there wouldn't be a latency test because they're
11 very different experiences. So there can't be a latency
12 test --

13 Q. Do you do IS scores with TikTok?

14 A. We can't do IS because it's a different experience.
15 But, it's a place where people turn to find information also,
16 which is sort of the broader point of what we are doing here.

17 Q. Finally, sir, you're aware that there's a history
18 function for the chatrooms that Google uses?

19 A. Yes.

20 Q. You know it's history on, history off, right?

21 A. Yes.

22 Q. And you're familiar with the fact that some of the
23 rooms default to history on or history off, right?

24 A. Yes.

25 Q. You understood before this case was filed that history

1 off meant that the chats would be destroyed or deleted after a
2 certain amount of time?

3 A. Yes.

4 Q. And from time to time, you asked people to turn
5 history off before or during your chats?

6 A. Well, I've certainly done that, because at the time
7 there was a policy at Google to have history off.

8 Q. And you --

9 A. And I just wanted to be compliant with that policy.

10 Q. You understood Google's policy was that history off
11 for chats amongst Google employees?

12 A. Yes.

13 MR. DINTZER: No further questions, Your Honor. We pass
14 the witness.

15 THE COURT: Okay. Thank you, Counsel.

16 Any redirect -- oh, Mr. Cavanaugh?

17 MR. CAVANAUGH: No questions for the witness.

18 MR. SMURZYNSKI: Very briefly, Your Honor.

19 REDIRECT EXAMINATION OF P. PANDURANG NAYAK

20 BY MR. SMURZYNSKI:

21 Q. Dr. Nayak, starting with this topic of latency, we
22 heard the term Folly. What does Folly stand for?

23 A. Actually, I really don't know.

24 Q. Well, I will -- let me direct your attention to 2027.

25 A. This is in which --

1 Q. It's in the white binder. It's one of the documents
2 you just looked at.

3 In the middle of the page there's the e-mail from Nicholas
4 Lim, and the first CC refers to a group.

5 A. Oh, Friends of Low Latency.

6 Q. Does that refresh your recollection as to what Folly
7 stands for?

8 A. Yes, Friends of Low Latency.

9 Q. Fundamentally, what is latency a result of when Google
10 search is returning a search results page?

11 A. So latency is a result of many different factors. It
12 depends on the amount of work you do on the server side to get
13 the best results. So all this going to the index, running the
14 machine learning, constructing the features, all of that is
15 factored in. This is server-side latency. Then there is the
16 transport latency. This is related to the latency of actually
17 sending the bits across the wire. And that is affected by not
18 only the speed of the network, but also how heavy the page is,
19 how many features you have, how many images you have and so
20 forth. Plus, if you want to -- an interactive page, how much
21 JavaScript you have to download onto the client.

22 And then there is the latency that is on the client
23 itself, which is actually running the JavaScript to render the
24 page. And in all this is all of the architectural elements of
25 how all this is done: Do you do all the work once up front and

1 send it all down; do you construct it as a streaming protocol
2 so that it looks like it's faster because the important stuff
3 is coming sooner. It also depends on things like do you do
4 https for security, because that takes a little time to encrypt
5 and decrypt things. So there's many factors that go into it.

6 Q. Could Google reduce its latency by spending less time
7 trying to produce quality results on the server side?

8 A. I mean, that's -- if we could do that, that would be
9 wonderful. But the reason we have a lot of sort of code on the
10 server side has to do with the fact that we think that this is
11 useful to users. That's why we've added those features. It's
12 improving the quality. And so one has to figure out how to
13 balance that. If it doesn't go to latency cost, we have to
14 figure out how to balance those things, optimize those things.
15 That's the hard work that needs to happen, is how you balance
16 these different factors, because they're really sort of
17 incomparable.

18 Q. And in general, how has Google approached that
19 trade-off between tolerating some amount of latency and making
20 sure that it delivers quality results to users?

21 A. We have tried to -- in the past, it used to be that
22 each time people launched things, this would go to a latency --
23 a latency czar kind of thing to say what kind of latency was
24 this incurring. But they couldn't really stop the launch,
25 because quality or experience was really quite the important

1 thing for us to do. We didn't want to trade that off. And so
2 they would work to make sure that we instituted the best
3 practices. But, at the end of the day, we wanted to build a
4 great experience for users, and so latency would creep up as a
5 result of that.

6 More recently, we have other process changes where
7 different teams have been given latency budgets that they can
8 work under, and that seems to be working better as a way of
9 keeping things in check. So there's various process changes
10 we've made to enable this kind of thing.

11 Q. You were asked a couple questions before our break
12 about mobile and desktop. Does location matter on desktop
13 queries?

14 A. Location matters on desktop also. If I come and
15 search for weather on desktop, I hope I would get weather in
16 Washington, D.C. as against, you know, in Chicago.

17 Q. And has Google used that knowledge from desktop
18 queries and how location has mattered in desktop queries
19 historically in its mobile applications?

20 A. Yes, absolutely.

21 Q. Counsel for plaintiffs drew a number of diagrams on
22 the chart over there. Navboost figured quite prominently in
23 them. Is navboost the only core algorithm that Google uses to
24 retrieve results?

25 A. No, absolutely not.

1 **Q.** How many signals does Google use, of which navboost is
2 one?

3 **A.** I mean, overall, there's a lot of signals. You know,
4 maybe over a hundred signals. But for retrieving documents,
5 the document itself is perhaps the most important thing, those
6 postings lists that we have that we use to retrieve documents
7 from. That's perhaps the most important thing, to get it down
8 to the tens of thousands. And then after that, there are many
9 factors, again. There are sort of code IR type, information
10 retrieval type algorithms which cull topicality and things,
11 which are really important. There is page quality. The
12 reliability of results, that's another big factor. There's
13 localization type things that go on there. And there is
14 navboost also in that.

15 **THE COURT:** I'm sorry to interrupt. Can I ask you to give
16 me a sense of where navboost is in the hierarchy of important
17 variables. Is it top 10 percent, 25 percent, top half? Where
18 would you rank it in terms of its significance in that process?

19 **THE WITNESS:** I mean, it's hard to give sort of a rank
20 ordering like this. I will say navboost is important, right.
21 So I don't want to minimize it in any way. But I will also say
22 that there are plenty of other signals that are also important,
23 like the ones I mentioned. And you can't really turn off some
24 of these things. I don't know what it would mean to turn off,
25 like, the index to the documents. That is in some ways like

1 the most important thing, the words on the page and so forth,
2 right. So it's a little hard to judge in that way. So I would
3 say that navboost is one of the important signals that we have.

4 **THE COURT:** Thank you.

5 **BY MR. SMURZYNSKI:**

6 **Q.** And, finally, you were asked some questions about a
7 blog post that you had written, and you were talking about the
8 expense of MUM in terms of energy and compute. How does Google
9 address the fact that the MUM model, in the teacher sense, has
10 expense in terms of both energy and compute in serving results
11 through its system?

12 **A.** So the truth is we don't run the MUM model in
13 production. So it's not as if the MUM model is running for
14 every query at run time. It's too big and too slow for that.
15 So what we do there is to train other smaller models using the
16 special training, like the classifier we talked about, which is
17 a much simpler model. And we run those simpler models in
18 production to serve the use cases.

19 **MR. SMURZYNSKI:** Thank you. I have no further questions.

20 **THE COURT:** Thank you. Dr. Nayak, thank you very much for
21 your time and testimony.

22 **THE WITNESS:** Thank you so much for having me.

23 **THE COURT:** Have a good evening.

24 (Witness not present)

25 **THE COURT:** So I take it we've come to the end of the day

1 in terms of evidentiary presentation. So tomorrow we have two
2 witnesses, correct, Mr. Cavanaugh -- or at least that's our
3 hope?

4 **MR. CAVANAUGH:** Yes, Your Honor, we have two witnesses.
5 We don't anticipate a closed session with either one.

6 **THE COURT:** Okay. Help me with timing, because tomorrow
7 is our last day, and I want to make sure we have enough time to
8 finish both.

9 **MR. CAVANAUGH:** We will have plenty of time. I anticipate
10 we'll end a little early.

11 **THE COURT:** Okay. Fine, terrific.

12 Mr. Schmidtlein, did you want to add anything?

13 **MR. SCHMIDTLEIN:** No, Your Honor.

14 **MS. WASZMER:** Good afternoon, Your Honor. Wendy Waszmer
15 for Google.

16 Just with the two witnesses Mr. Cavanaugh mentioned, I
17 think he and we do not have any confidentiality issues.
18 There's just one item I've raised with counsel for Microsoft
19 about, I believe, Mr. Cavanaugh's second witness, the Sky
20 witness, Mr. Vallez. I've just flagged one potential document
21 that could come up, depending on what the States' scope is.
22 We've proposed a way that we could do it in open court, I
23 believe we should be able to do it, but Microsoft counsel just
24 needs some time today to think about it.

25 So, as of now, I think they just wanted me to reserve

1 their ability to come in tomorrow and raise it if they do need
2 sealing, but we've proposed a way to do it in open court.

3 **THE COURT:** Okay. Thank you, I appreciate it.

4 So, as I said earlier, what we'll do sort of here forward
5 is I will ask counsel to just give me a heads up about
6 anticipated closed sessions for the next day.

7 What was the name of the witness, I'm sorry?

8 **MR. SCHMIDTLEIN:** Vallez, V-A-L-L-E-Z, is the witness that
9 may have this issue.

10 **THE COURT:** What's the first name?

11 **MR. SCHMIDTLEIN:** Paul.

12 **THE COURT:** Paul, okay, great.

13 So I'll -- you know, what I will do is we'll post
14 something this evening just providing notice, and anyone that
15 would like to be heard the next morning about it can.
16 Hopefully, we'll get this resolved and it won't be an issue,
17 but we'll proceed in that fashion.

18 **MR. CAVANAUGH:** He'll be the second witness tomorrow, Your
19 Honor.

20 **THE COURT:** Okay. So if you expect, Mr. Cavanaugh, to
21 finish early, what I would propose is that our discussion about
22 any -- the proposed modifications that the New York Times has
23 made, that we push that to the end of the day. I'd like to be
24 able to give their counsel a general time where we think we
25 might end up.

1 **MR. CAVANAUGH:** I gave Mr. Sommer a prediction of 3:30. I
2 think if we went with 4:00 o'clock, Your Honor, I think we'd be
3 safe.

4 **THE COURT:** Well, why don't I just tell him 3:30, because
5 that's about usually when we -- that may work, so great. So
6 we'll notify them about that.

7 Okay, anything else?

8 **MR. DINTZER:** Not from the DOJ plaintiffs, Your Honor.

9 **MR. CAVANAUGH:** No.

10 **MR. SCHMIDTLEIN:** No, Your Honor.

11 **THE COURT:** Just one last thing on my list, then. So we
12 have now have had the opportunity to review and make now
13 available -- and we'll post a minute order to this effect as
14 well -- the previously closed sessions for Mr. Yoo, Mr. Lehman
15 and Mr. Roszak. As before, we did conduct -- well, I should
16 say, before we conducted a line-by-line evaluation, we did
17 request input from the parties. We did conduct a line-by-line
18 evaluation of their proposals, and applied the Hubbard factors
19 to those proposals. Just, again, in terms of those factors, I
20 recognize that one in six probably certainly favor disclosure.
21 And given the nature of some of this, certainly I think those
22 factors favor disclosure.

23 There are other aspects of the requests for sealing that I
24 think, however, arguably outweigh the request for disclosure.
25 And specifically they relate to, in this case, concerns about

1 making public information that hasn't previously been made
2 public, which is a factor to consider. And the potential for
3 competitive harm, specifically in this case to Google, since
4 all three of those witnesses related to them.

5 So just applying all of those factors -- and I'm not going
6 to -- applying those factors, these are sort of the general
7 categories of -- general subject matters that we did agree to
8 redact. Again, one, personally identifying information, like
9 e-mail addresses; two, code names and internal projects --
10 excuse me, code names and internal terms for projects that are
11 not otherwise public -- and I'm speaking just in terms of the
12 code name itself.

13 We also have -- as has been consistent with what has been
14 done today, that to the extent that there's proprietary
15 information revealed in the transcripts about how certain
16 systems or features work, including any data inputs and
17 programming details -- for example, the number of training
18 examples for a search algorithm or the number of pages that a
19 search engine indexes, those were numbers that we thought were
20 proprietary and arguably trade secrets for Google that we did
21 accept the proposed redactions.

22 We did not, however, accept all of them. For example,
23 sort of high-level statements about one firm's product by
24 another firm, including results of product comparisons with
25 other firms, some of which we've heard about today in open

1 court, such as Google's internal quality assessments about
2 Bing, we did not redact.

3 Similarly, there was -- I think it was with Mr. Roszak,
4 there was a discussion of an internal Google assessment of
5 Bing's -- what it would take for Bing essentially to become the
6 default for Apple, and some of the financial calculations that
7 Google was estimating about what it would take for Bing to
8 potentially secure that default. Those we did not redact.

9 And then we did not redact what we thought of as sort of a
10 high-level description of certain features of technology,
11 particularly that that's been around for a long time, which I
12 think has sort of been consistent with the way we treated it
13 today -- so a high-level description of what the technology is.
14 But, again, the particular inputs we did not -- we did redact
15 the particular inputs, because I thought those were more
16 aligned with trade secrets that, if disclosed, could result in
17 competitive harm, okay.

18 So with that, is there anything else? Then we will
19 adjourn for the evening.

20 **MR. DINTZER:** Not from us, Your Honor.

21 **THE COURT:** Thank you all very much. We'll see you in the
22 morning.

23 (Proceedings adjourned at 3:54 p.m.)
24
25

C E R T I F I C A T E

I, Jeff M. Hook, Official Court Reporter,
certify that the foregoing is a true and correct transcript of
the record of proceedings in the above-entitled matter.

October 18, 2023

DATE



Jeff M. Hook

BY MR. DINTZER: [15] 6395/14 6400/17 6405/13 6407/12 6428/6 6434/3 6437/7 6439/16 6442/18 6445/23 6451/24 6454/8 6458/1 6462/21 6465/12 BY MR. SMURZYNSKI: [2] 6468/19 6473/4 MR. CAVANAUGH: [6] 6468/16 6474/3 6474/8 6475/17 6475/25 6476/8 MR. DINTZER: [26] 6395/3 6395/7 6395/10 6395/12 6414/3 6432/19 6435/12 6435/18 6439/13 6442/5 6442/7 6442/9 6442/14 6451/19 6453/20 6453/23 6454/2 6454/23 6455/9 6457/21 6462/15 6462/20 6465/8 6468/12 6476/7 6478/19 MR. SCHMIDTLEIN: [4] 6474/12 6475/7 6475/10 6476/9 MR. SMURZYNSKI: [12] 6432/15 6435/14 6439/15 6442/11 6442/16 6451/21 6454/24 6457/23 6462/17 6465/9 6468/17 6473/18 MS. WASZMER: [1] 6474/13 THE COURT: [47] 6395/1 6395/6 6395/9 6395/11 6400/14 6405/8 6406/5 6407/3 6407/11 6427/8 6427/12 6427/15 6427/21 6428/5 6433/14 6433/21 6434/2 6435/15 6437/1 6442/8 6442/10 6442/17 6445/9 6451/22 6453/22 6453/25 6454/3 6454/6 6455/6 6457/24 6462/18 6465/10 6468/14 6472/14 6473/3 6473/19 6473/22 6473/24 6474/5 6474/10 6475/2 6475/9	6475/11 6475/19 6476/3 6476/10 6478/20 THE WITNESS: [15] 6400/15 6405/11 6406/9 6407/5 6427/11 6427/13 6427/16 6427/25 6433/19 6433/22 6437/3 6442/6 6445/11 6472/18 6473/21 ' '16 [1] 6397/7 '17 [1] 6397/7 'San [1] 6461/12 'Admitted [6] 6394/11 6394/12 6394/13 6394/14 6394/15 6394/16 1 10 [1] 6467/4 10 percent [1] 6472/17 10,000,000 [1] 6399/7 10019 [1] 6393/12 10036 [1] 6392/24 1087 [1] 6414/3 10:00 [1] 6442/13 10K [1] 6407/24 1100 [1] 6392/14 1133 [1] 6392/23 11th [1] 6414/8 12 years [1] 6467/4 129 [1] 6409/25 13 [1] 6405/21 13 months [3] 6410/21 6432/11 6433/18 1300 [1] 6393/4 1301 [1] 6393/11 15 [1] 6454/1 15,000 [6] 6424/11 6424/12 6424/20 6425/8 6425/10 6426/8 15th [1] 6414/9 16,000 [1] 6423/20 17 [1] 6423/15 17.003 [1] 6423/16 1720 [1] 6414/12 1723 [1] 6421/14 1724 [1] 6421/15 18 [1] 6392/5 18 months [2] 6405/24 6410/21 19th [1] 6462/24 1:20-cv-3010 [1] 6392/4 1:32 [1] 6392/6	2 20 [2] 6431/12 6431/19 200 [1] 6399/15 20001 [2] 6392/17 6393/25 20005 [1] 6392/15 20024 [1] 6393/9 2005 [1] 6402/22 2014 [5] 6397/3 6414/9 6462/2 6462/3 6462/10 2015 [3] 6397/3 6397/7 6430/14 2017 [5] 6405/23 6409/6 6409/13 6458/5 6462/24 2019 [2] 6435/10 6435/20 2020 [3] 6397/9 6423/24 6465/6 2021 [1] 6451/10 2022 [1] 6461/8 2023 [1] 6392/5 2027 [3] 6462/16 6462/19 6468/24 209 [1] 6392/19 20th [1] 6465/18 21st [1] 6465/6 2200 [2] 6392/23 6392/23 24 [1] 6392/7 25 percent [1] 6472/17 2:55 p.m [1] 6454/5 2X [1] 6437/5 3 3.69 [1] 6461/12 30 [2] 6431/12 6431/19 300 [3] 6407/17 6407/19 6407/24 300 milliseconds [5] 6458/10 6463/5 6463/9 6463/19 6463/24 3010 [1] 6392/4 333 [1] 6393/24 3:16 p.m [1] 6454/6 3:30 [2] 6476/1 6476/4 3:54 p.m [1] 6478/23 4 400 [1] 6454/14 400 billion [1] 6397/10 40th [1] 6393/11 4417 [1] 6435/21 450 [1] 6392/17 4:00 [1] 6476/2 5 500-pound [2]	6428/22 6429/6 5213 [1] 6439/11 5231 [1] 6440/3 5233 [1] 6440/19 565 [1] 6461/13 6 6 percent [4] 6417/15 6417/16 6418/18 6418/18 600 [1] 6392/19 60604 [1] 6392/20 616,386 [2] 6426/7 6427/10 6395 [1] 6394/4 6435 [1] 6394/11 6451 [1] 6394/12 6455 [1] 6394/13 6458 [1] 6394/14 6462 [1] 6394/15 6465 [1] 6394/16 6468 [1] 6394/5 66 [1] 6417/22 680 [1] 6393/9 7 7122 [1] 6455/13 7123 [1] 6456/10 7124 [1] 6457/3 757,000 [2] 6425/4 6425/5 7th [1] 6393/4 8 80203 [1] 6393/5 8074 [1] 6442/25 8075 [1] 6446/24 86 [1] 6417/24 A A/B [1] 6410/13 ability [2] 6453/6 6475/1 ablation [1] 6409/13 able [4] 6395/5 6426/16 6474/23 6475/24 above [1] 6479/5 above-entitled [1] 6479/5 absolute [1] 6434/20 absolutely [6] 6412/13 6422/4 6427/8 6441/20 6471/20 6471/25 accept [2] 6477/21 6477/22 access [1] 6455/11 accurate [2] 6427/22 6440/17 across [5] 6431/25 6441/23 6441/25 6459/16 6469/17 action [2] 6392/3 6457/21	actively [1] 6409/16 actual [6] 6411/4 6428/20 6436/4 6441/8 6441/13 6441/13 actually [19] 6396/21 6411/16 6417/19 6421/18 6422/22 6422/23 6426/22 6426/24 6429/7 6429/25 6437/4 6441/18 6443/15 6449/25 6450/14 6455/20 6468/23 6469/16 6469/23 add [6] 6404/12 6408/9 6408/10 6426/15 6451/4 6474/12 added [2] 6408/13 6470/11 adding [3] 6460/7 6460/21 6464/21 additional [2] 6424/17 6427/19 additive [1] 6430/22 address [1] 6473/9 addresses [2] 6460/22 6477/9 addressing [1] 6459/14 adequate [1] 6409/20 adjourn [1] 6478/19 adjourned [1] 6478/23 adjust [2] 6399/24 6431/12 admit [1] 6455/7 admitted [12] 6414/4 6435/16 6435/18 6451/23 6451/24 6455/9 6457/25 6458/1 6462/19 6462/20 6465/11 6465/12 advanced [2] 6429/10 6452/2 advantage [1] 6428/19 affected [3] 6461/3 6461/4 6469/17 afternoon [3] 6392/7 6395/16 6474/14 afterwards [1] 6442/16 again [13] 6396/24 6398/13 6408/12 6408/13 6419/8 6426/5 6426/9 6450/13 6457/10 6472/9
--	--	--	---	--

A	anonymized [1] 6395/24	6413/21 6414/24	become [3] 6459/6 6459/7 6478/5	6457/20 6458/3 6458/6 6458/9
again... [3] 6476/19 6477/8 6478/14	anticipate [2] 6474/5 6474/9	aspect [1] 6460/22	becoming [1] 6437/15	6458/15 6458/21 6461/10 6461/14
against [3] 6410/14 6467/8 6471/16	anticipated [1] 6475/6	aspects [1] 6476/23	begins [2] 6444/21 6447/17	6462/4 6462/8 6462/12 6462/14
aggregate [2] 6441/21 6441/23	Antitrust [1] 6393/4	assessment [1] 6478/4	behaviors [1] 6414/21	6463/4 6463/5 6463/25 6465/3
ago [3] 6402/17 6434/9 6443/6	anymore [1] 6461/6	assessments [1] 6478/1	behind [1] 6460/9	6465/4 6466/11 6466/14 6466/18
agree [4] 6397/2 6437/13 6445/1 6477/7	Anyways [1] 6435/3	assume [1] 6456/18	beings [1] 6426/23	6466/24 6467/2 6478/2 6478/5 6478/7
Ah [1] 6451/13	apologize [1] 6426/20	ATMs [1] 6419/12	Belknap [1] 6392/22	Bing's [3] 6396/18 6457/15 6478/5
ahead [3] 6442/15 6462/1 6462/1	Apparently [1] 6435/9	attempt [1] 6458/13	BELLSHAW [1] 6392/16	bit [3] 6419/16 6420/5 6443/14
AI [2] 6452/2 6452/15	appear [1] 6401/24	augmented [2] 6448/15 6448/18	BENCH [1] 6392/10	bits [1] 6469/17
al [1] 6392/3	APPEARANCES [2] 6392/12 6393/1	August [2] 6414/8 6414/9	Benedict [1] 6465/14	black [7] 6423/11 6436/2 6437/1 6437/19 6437/24 6438/3 6444/15
alarm [1] 6457/9	appears [4] 6441/21 6455/1 6456/13 6461/10	August 11th [1] 6414/8	benefit [1] 6452/9	blanket [1] 6450/4
algorithm [4] 6399/19 6448/16 6471/23 6477/18	Apple [1] 6478/6	August 15th [1] 6414/9	BERT [20] 6431/6 6433/4 6433/6 6433/6 6433/9 6433/10 6433/10 6439/9 6440/6 6440/7 6440/9 6448/13 6448/16 6448/16 6448/17 6448/17 6448/18 6448/21 6449/17 6449/21	blind [1] 6432/23
algorithms [8] 6399/15 6399/20 6400/1 6400/22 6404/19 6451/1 6453/17 6472/10	application [2] 6433/6 6452/10	available [1] 6476/13	BERT's [1] 6440/11	blog [2] 6451/14 6473/7
aligned [1] 6478/16	application-specif ic [1] 6452/10	Avenue [4] 6392/23 6393/9 6393/11 6393/24	best [7] 6400/4 6408/23 6412/17 6450/8 6459/18 6469/13 6471/2	blue [5] 6403/17 6403/21 6404/8 6423/24 6428/2
allow [1] 6439/3	applications [2] 6452/12 6471/19	aware [3] 6396/7 6396/9 6467/17	better [14] 6397/19 6398/2 6404/14 6410/18 6411/14 6411/21 6411/24 6429/15 6439/20 6445/4 6448/18 6450/17 6466/25 6471/8	bold [1] 6447/9
allows [2] 6427/19 6460/1	applied [2] 6454/7 6476/18	B	beyond [2] 6420/10 6421/17	book [3] 6450/23 6454/10 6454/11
along [1] 6425/17	applying [3] 6459/18 6477/5 6477/6	back [27] 6395/2 6400/19 6400/24 6402/22 6403/1 6406/4 6419/10 6421/25 6422/23 6427/20 6430/4 6430/5 6438/3 6442/16 6445/25 6449/4 6449/20 6450/23 6454/6 6457/10 6460/2 6460/8 6460/17 6460/19 6462/10 6464/22 6466/10	big [10] 6410/22 6410/22 6419/15 6419/20 6440/13 6454/11 6459/3 6459/8 6472/12 6473/14	both [9] 6396/18 6401/11 6403/15 6418/7 6418/8 6436/23 6444/5 6473/10 6474/8
always [2] 6423/6 6450/7	approach [1] 6395/11	Background [2] 6461/9 6461/9	bigger [9] 6397/19 6397/24 6397/25 6398/1 6420/3 6434/19 6452/19 6452/19 6452/25	bottom [7] 6414/12 6417/5 6420/16 6421/14 6435/21 6456/1 6465/17
ambitious [1] 6464/4	approached [1] 6470/18	balance [3] 6470/13 6470/14 6470/15	billion [1] 6397/10	bought [1] 6400/16
AMERICA [4] 6392/3 6413/10 6419/11 6419/14	appropriate [1] 6454/22	Bank [3] 6413/10 6419/10 6419/14	binder [7] 6409/2 6414/2 6414/3 6423/11 6439/8 6442/3 6469/1	box [9] 6416/3 6424/21 6425/1 6425/2 6425/3 6437/2 6437/24 6438/3 6444/15
Americas [2] 6392/23 6393/11	approval [3] 6427/24 6428/2 6428/3	banking [1] 6413/14	Bing [32] 6434/15 6434/20 6449/5 6456/13 6456/19 6456/24 6456/25	boxes [1] 6432/18
AMIT [1] 6392/10	approximate [1] 6458/10	Bankruptcy [1] 6393/24		bracket [1] 6420/16
among [1] 6407/10	April [2] 6465/6 6465/18	bar [1] 6423/24		Brain [1] 6447/13
amongst [1] 6468/11	April 20th [1] 6465/18	Bard [4] 6445/15 6445/25 6446/2 6448/7		branches [1] 6413/13
amortized [1] 6452/11	April 21st [1] 6465/6	based [2] 6412/3 6448/6		break [2] 6415/14 6471/11
amount [19] 6398/4 6398/6 6398/10 6406/1 6409/18 6409/18 6411/3 6418/9 6432/13 6439/2 6443/23 6444/25 6447/21 6449/6 6449/8 6456/7 6468/2 6469/12 6470/19	architectural [1] 6469/24	basically [2] 6401/23 6424/19		briefly [1] 6468/18
analyses [1] 6414/20	area [1] 6421/7	Bates [3] 6414/11 6414/12 6455/13		bring [4] 6399/15 6400/2 6400/23 6428/24
analysis [4] 6414/24 6438/4 6463/1 6463/4	arguably [2] 6476/24 6477/20			brings [1] 6424/17
And you [1] 6468/8	around [3] 6412/16 6423/21 6478/11			
	arrive [2] 6458/9 6463/5			
	arrives [1] 6456/19			
	art [1] 6429/6			
	article [2]			

B	6450/4 6452/2 6452/7 6452/15 6453/24 6454/2 6458/21 6458/25 6459/20 6460/3 6460/7 6460/10 6460/20 6460/25 6466/20 6471/7 6472/15 6475/15	cetera [1] 6440/14 chain [2] 6462/23 6465/7 chance [3] 6408/5 6408/8 6408/10 change [12] 6398/24 6412/6 6424/4 6425/21 6425/22 6426/11 6426/13 6426/13 6453/21 6464/4 6464/14 6464/25 changes [5] 6426/11 6426/13 6426/17 6471/6 6471/9 characterization [1] 6404/23 characterize [2] 6404/15 6408/14 chart [2] 6417/18 6471/22 charts [1] 6435/3 ChatGPT [2] 6445/15 6448/6 chatrooms [1] 6467/18 chats [3] 6468/1 6468/5 6468/11 cheaper [1] 6447/14 check [2] 6439/14 6471/9 Chicago [2] 6392/20 6471/16 choice [1] 6410/22 circle [1] 6399/13 Civil [1] 6392/3 claim [1] 6448/8 classifier [1] 6473/16 clear [3] 6396/10 6405/9 6449/11 clearly [3] 6429/17 6450/17 6466/18 clever [1] 6425/18 cleverly [1] 6459/9 click [12] 6411/20 6411/25 6428/16 6428/19 6431/9 6432/12 6438/14 6440/1 6448/22 6450/10 6450/11 6450/12 clicked [1] 6421/5 clicks [7] 6405/15 6407/21 6428/19 6433/20 6434/12 6434/13 6434/18 client [4] 6464/3 6464/12 6469/21	6469/22 close [1] 6422/8 closed [3] 6474/5 6475/6 6476/14 closer [1] 6460/24 CO [1] 6393/5 coarse [2] 6429/19 6429/21 code [6] 6457/9 6470/9 6472/9 6477/9 6477/10 6477/12 coding [1] 6459/12 collected [1] 6433/18 Colorado [3] 6392/21 6393/2 6393/3 COLUMBIA [1] 6392/1 column [2] 6427/23 6428/2 combined [1] 6415/13 combines [1] 6446/3 coming [2] 6422/14 6470/3 comments [1] 6457/8 common [3] 6417/6 6436/13 6447/19 common-sense [2] 6436/13 6447/19 company [2] 6420/17 6458/21 comparative [1] 6463/4 compared [2] 6428/16 6434/14 comparison [1] 6456/25 comparisons [1] 6477/24 compelling [1] 6429/9 competitive [2] 6477/3 6478/17 complementary [5] 6430/19 6430/21 6437/10 6437/16 6437/17 complete [2] 6455/4 6455/5 completely [2] 6421/20 6447/21 completeness [1] 6455/8 complex [1] 6445/22 complexity [1] 6446/10 compliant [1] 6468/9 complicated [1] 6445/22 components [1]	6431/17 comprehensive [3] 6397/18 6397/22 6464/23 compress [1] 6459/8 computation [3] 6444/25 6447/15 6452/4 computationally [2] 6447/5 6447/8 compute [3] 6460/13 6473/8 6473/10 computed [1] 6423/4 conceptually [1] 6406/7 concern [1] 6461/18 concerning [2] 6397/16 6461/20 concerns [1] 6476/25 conduct [2] 6476/15 6476/17 conducted [2] 6414/20 6476/16 confident [1] 6444/17 confidentiality [1] 6474/17 confused [1] 6418/22 connection [1] 6461/2 connectivity [2] 6461/4 6461/7 Connolly [1] 6393/8 cons [1] 6428/16 Consequently [1] 6447/17 consider [1] 6477/2 consistent [2] 6477/13 6478/12 consistently [2] 6458/7 6458/19 constant [1] 6449/8 constantly [1] 6424/15 Constitution [1] 6393/24 constrained [1] 6446/20 constraint [1] 6446/22 construct [1] 6470/1 constructing [3] 6459/24 6460/16 6469/14 consumptive [1] 6452/2 CONT [1] 6393/1 content [1]
C				
cadence [1] 6432/23 calculations [1] 6478/6 California [1] 6421/19 call [2] 6438/20 6464/14 called [11] 6399/15 6401/17 6404/20 6405/10 6406/14 6406/16 6408/17 6408/18 6408/19 6411/16 6448/13 can [51] 6395/23 6398/5 6399/24 6403/6 6406/4 6406/6 6407/9 6407/14 6409/21 6409/25 6411/21 6412/6 6419/6 6419/21 6421/25 6422/9 6422/15 6424/9 6429/16 6429/18 6430/20 6433/15 6433/16 6435/9 6438/25 6439/14 6439/16 6439/19 6440/3 6442/15 6442/15 6445/19 6449/17	6458/15 categories [2] 6413/5 6477/7 caught [1] 6465/4 cause [1] 6458/20 caution [1] 6432/19 CAVANAUGH [5] 6392/22 6468/16 6474/2 6474/16 6475/20 Cavanaugh's [1] 6474/19 caveats [1] 6455/6 CC [1] 6469/4 certain [6] 6438/18 6446/18 6446/18 6468/2 6477/15 6478/10 certainly [21] 6398/12 6403/19 6404/9 6413/15 6416/22 6422/21 6429/8 6429/10 6430/13 6430/22 6431/16 6432/25 6437/5 6452/18 6461/19 6462/10 6464/1 6466/16 6468/6 6476/20 6476/21 certify [1] 6479/4	cetera [1] 6440/14 chain [2] 6462/23 6465/7 chance [3] 6408/5 6408/8 6408/10 change [12] 6398/24 6412/6 6424/4 6425/21 6425/22 6426/11 6426/13 6426/13 6453/21 6464/4 6464/14 6464/25 changes [5] 6426/11 6426/13 6426/17 6471/6 6471/9 characterization [1] 6404/23 characterize [2] 6404/15 6408/14 chart [2] 6417/18 6471/22 charts [1] 6435/3 ChatGPT [2] 6445/15 6448/6 chatrooms [1] 6467/18 chats [3] 6468/1 6468/5 6468/11 cheaper [1] 6447/14 check [2] 6439/14 6471/9 Chicago [2] 6392/20 6471/16 choice [1] 6410/22 circle [1] 6399/13 Civil [1] 6392/3 claim [1] 6448/8 classifier [1] 6473/16 clear [3] 6396/10 6405/9 6449/11 clearly [3] 6429/17 6450/17 6466/18 clever [1] 6425/18 cleverly [1] 6459/9 click [12] 6411/20 6411/25 6428/16 6428/19 6431/9 6432/12 6438/14 6440/1 6448/22 6450/10 6450/11 6450/12 clicked [1] 6421/5 clicks [7] 6405/15 6407/21 6428/19 6433/20 6434/12 6434/13 6434/18 client [4] 6464/3 6464/12 6469/21	6469/22 close [1] 6422/8 closed [3] 6474/5 6475/6 6476/14 closer [1] 6460/24 CO [1] 6393/5 coarse [2] 6429/19 6429/21 code [6] 6457/9 6470/9 6472/9 6477/9 6477/10 6477/12 coding [1] 6459/12 collected [1] 6433/18 Colorado [3] 6392/21 6393/2 6393/3 COLUMBIA [1] 6392/1 column [2] 6427/23 6428/2 combined [1] 6415/13 combines [1] 6446/3 coming [2] 6422/14 6470/3 comments [1] 6457/8 common [3] 6417/6 6436/13 6447/19 common-sense [2] 6436/13 6447/19 company [2] 6420/17 6458/21 comparative [1] 6463/4 compared [2] 6428/16 6434/14 comparison [1] 6456/25 comparisons [1] 6477/24 compelling [1] 6429/9 competitive [2] 6477/3 6478/17 complementary [5] 6430/19 6430/21 6437/10 6437/16 6437/17 complete [2] 6455/4 6455/5 completely [2] 6421/20 6447/21 completeness [1] 6455/8 complex [1] 6445/22 complexity [1] 6446/10 compliant [1] 6468/9 complicated [1] 6445/22 components [1]	6431/17 comprehensive [3] 6397/18 6397/22 6464/23 compress [1] 6459/8 computation [3] 6444/25 6447/15 6452/4 computationally [2] 6447/5 6447/8 compute [3] 6460/13 6473/8 6473/10 computed [1] 6423/4 conceptually [1] 6406/7 concern [1] 6461/18 concerning [2] 6397/16 6461/20 concerns [1] 6476/25 conduct [2] 6476/15 6476/17 conducted [2] 6414/20 6476/16 confident [1] 6444/17 confidentiality [1] 6474/17 confused [1] 6418/22 connection [1] 6461/2 connectivity [2] 6461/4 6461/7 Connolly [1] 6393/8 cons [1] 6428/16 Consequently [1] 6447/17 consider [1] 6477/2 consistent [2] 6477/13 6478/12 consistently [2] 6458/7 6458/19 constant [1] 6449/8 constantly [1] 6424/15 Constitution [1] 6393/24 constrained [1] 6446/20 constraint [1] 6446/22 construct [1] 6470/1 constructing [3] 6459/24 6460/16 6469/14 consumptive [1] 6452/2 CONT [1] 6393/1 content [1]

C	CPS/Antitrust [1] 6393/4 craft [1] 6438/19 create [3] 6397/22 6408/3 6422/16 created [2] 6424/1 6438/24 creating [1] 6413/4 creep [1] 6471/4 crisp [1] 6444/19 critical [3] 6400/1 6400/22 6422/25 cross [4] 6394/4 6395/14 6464/2 6464/12 Cross-Examination [2] 6394/4 6395/14 cross-server [2] 6464/2 6464/12 cull [1] 6472/10 culled [3] 6404/6 6407/5 6407/15 culling [3] 6406/9 6422/11 6422/13 culls [1] 6405/12 culture [3] 6464/4 6464/15 6464/25 current [1] 6437/5 cv [1] 6392/4	6448/22 6448/24 6449/1 6449/5 6449/6 6449/6 6449/8 6449/10 6449/12 6449/13 6449/18 6449/23 6449/25 6450/5 6450/6 6450/8 6450/8 6450/10 6450/10 6450/11 6450/12 6450/14 6450/17 6450/18 6450/20 6477/16 datasets [1] 6413/5 DATE [1] 6479/10 dates [1] 6402/17 DAVID [1] 6392/18 day [6] 6392/7 6471/3 6473/25 6474/7 6475/6 6475/23 days [2] 6432/17 6449/23 DC [5] 6392/5 6392/15 6392/17 6393/9 6393/25 de [1] 6395/24 de-identified [1] 6395/24 decide [3] 6411/23 6427/4 6427/4 decides [1] 6427/5 deciding [1] 6410/21 decision [7] 6409/15 6410/22 6410/23 6411/3 6411/5 6430/15 6446/4 decisions [2] 6410/25 6411/3 deck [1] 6455/2 decrease [4] 6397/16 6398/6 6458/14 6460/1 decreasing [2] 6458/18 6459/10 decrypt [1] 6470/5 deep [18] 6399/24 6400/3 6400/5 6400/16 6408/5 6430/13 6430/14 6431/1 6431/8 6437/20 6438/3 6438/8 6438/10 6443/5 6444/25 6445/22 6448/1 6448/12 DeepRank [22] 6431/4 6433/1 6433/7 6433/10 6433/12 6435/21 6435/22 6436/12 6436/20 6436/23 6437/10 6437/17	6443/2 6443/7 6443/16 6444/3 6444/8 6447/1 6447/9 6447/18 6447/25 6449/24 default [3] 6467/23 6478/6 6478/8 Defendant [2] 6392/7 6393/7 defendants [1] 6439/8 defense [1] 6395/4 defined [2] 6463/18 6464/3 definitely [1] 6441/10 definition [2] 6445/2 6451/6 Deja [1] 6457/4 delete [2] 6396/1 6396/8 deleted [1] 6468/1 deliberately [1] 6432/17 delivers [1] 6470/20 demonstrative [2] 6399/10 6423/8 demonstratives [1] 6402/5 Denver [1] 6393/5 Department [4] 6392/14 6392/16 6392/19 6393/3 depend [2] 6420/3 6420/5 depending [2] 6412/6 6474/21 depends [6] 6424/8 6430/12 6450/13 6450/13 6469/12 6470/3 deposition [2] 6404/20 6412/20 depth [1] 6413/21 descending [1] 6465/21 describing [1] 6438/22 description [2] 6478/10 6478/13 desktop [29] 6413/2 6413/8 6414/18 6414/25 6415/12 6415/17 6415/25 6416/12 6416/18 6417/3 6417/6 6417/20 6418/3 6418/5 6418/7 6418/8 6418/11 6418/12 6419/5 6419/13 6420/2 6420/10 6420/17 6471/12 6471/12 6471/14 6471/15 6471/17	6471/18 desktop-dominant [3] 6415/25 6417/20 6418/3 destroyed [1] 6468/1 detailed [1] 6396/13 details [4] 6397/1 6413/22 6420/3 6477/17 determine [1] 6411/21 development [2] 6421/24 6422/25 device [1] 6417/2 diagrams [1] 6471/21 dial [1] 6461/6 dial-up [1] 6461/6 Diego [1] 6461/12 difference [2] 6417/3 6420/10 differences [1] 6413/7 different [31] 6401/8 6402/1 6413/5 6414/18 6414/19 6415/16 6417/11 6419/5 6420/11 6420/11 6421/17 6421/18 6421/21 6425/23 6425/24 6428/12 6428/15 6430/23 6436/16 6441/9 6441/10 6446/4 6449/5 6452/12 6458/21 6459/17 6467/11 6467/14 6469/11 6470/16 6471/7 difficult [1] 6452/23 difficulty [1] 6452/17 DINTZER [4] 6392/13 6394/4 6395/3 6395/16 direct [5] 6399/14 6412/16 6413/8 6423/2 6468/24 directed [1] 6442/9 direction [1] 6430/21 directions [1] 6458/22 disclosed [1] 6478/16 disclosure [3] 6476/20 6476/22 6476/24 discussed [5] 6400/6 6403/7 6433/1 6433/4 6450/7
----------	--	---	---	---

D	6397/15 6399/15 6404/16 6406/16 6406/24 6407/2 6415/14 6420/20 6431/19 6440/12 6443/14 6443/21 6444/21 6449/18 6453/4 6454/4 6456/3 6470/1 6472/7	effort [2] 6432/21 6461/10 eight [1] 6435/22 either [2] 6459/8 6474/5 element [1] 6448/1 elements [2] 6458/20 6469/24 else [9] 6397/19 6397/20 6403/10 6433/19 6436/25 6438/6 6461/21 6476/7 6478/18 emphasize [1] 6452/17 empirical [3] 6449/14 6450/1 6450/15 employees [1] 6468/11 employs [1] 6453/16 enable [1] 6471/10 encode [2] 6447/21 6459/9 encrypt [1] 6470/4 end [9] 6401/2 6406/19 6438/8 6438/8 6471/3 6473/25 6474/10 6475/23 6475/25 end-to-end [1] 6438/8 ending [1] 6457/10 ends [1] 6464/22 energy [4] 6452/2 6452/10 6473/8 6473/10 engine [7] 6401/12 6408/20 6419/3 6419/6 6435/4 6459/20 6477/19 engineer [2] 6424/23 6425/18 engineering [2] 6459/11 6462/11 engineers [1] 6397/17 enormous [1] 6453/5 enough [13] 6397/21 6398/3 6398/7 6398/9 6403/20 6406/24 6406/25 6416/24 6447/20 6449/13 6450/2 6457/7 6474/7 enrich [1] 6459/3 entire [2] 6426/8 6441/24 entirely [1] 6437/20 entitled [1]	6479/5 equal [4] 6397/19 6397/20 6450/5 6450/9 essentially [2] 6419/13 6478/5 estimating [1] 6478/7 et [2] 6392/3 6440/13 evaluate [2] 6429/1 6441/8 evaluation [7] 6409/22 6421/23 6422/24 6422/24 6440/23 6476/16 6476/18 evaluations [2] 6424/20 6446/7 evaluator [2] 6410/15 6410/17 even [11] 6400/23 6402/23 6408/12 6417/11 6420/14 6421/10 6426/14 6438/23 6439/19 6441/12 6448/18 evening [3] 6473/23 6475/14 6478/19 events [3] 6432/23 6449/2 6457/19 everybody [1] 6395/2 evidence [12] 6394/11 6394/12 6394/13 6394/14 6394/15 6394/16 6435/18 6451/24 6455/9 6458/1 6462/20 6465/12 evidentiary [1] 6474/1 exact [1] 6434/8 exactly [8] 6407/6 6434/10 6438/16 6438/21 6444/16 6450/16 6461/22 6466/17 exam [2] 6423/2 6432/18 examination [5] 6394/4 6394/5 6395/14 6454/8 6468/19 example [15] 6406/22 6411/25 6413/10 6414/7 6420/13 6420/13 6420/16 6420/20 6421/4 6427/24 6449/22 6460/15 6467/7 6477/17 6477/22 examples [1] 6477/18 excerpt [2] 6454/12 6455/7	excuse [4] 6440/8 6442/7 6453/12 6477/10 exercises [1] 6467/6 EXHIBIT [13] 6394/10 6394/11 6394/12 6394/13 6394/14 6394/15 6394/16 6435/18 6451/24 6455/9 6458/1 6462/20 6465/12 existing [1] 6453/10 expect [1] 6475/20 expense [4] 6446/13 6448/10 6473/8 6473/10 expensive [12] 6431/15 6431/16 6431/22 6447/5 6447/8 6447/12 6447/14 6452/7 6452/16 6452/18 6452/24 6459/7 experience [12] 6396/22 6411/15 6428/23 6429/6 6441/3 6459/3 6464/18 6464/19 6464/21 6467/14 6470/25 6471/4 experiences [1] 6467/11 experiment [13] 6410/4 6410/5 6410/10 6410/12 6411/10 6411/12 6412/1 6424/17 6424/24 6424/24 6424/25 6427/25 6428/5 experimental [2] 6426/6 6426/17 experimentation [3] 6409/19 6409/20 6428/4 experimenting [1] 6424/4 experiments [13] 6409/8 6409/12 6409/22 6409/23 6411/16 6424/25 6425/2 6426/8 6427/12 6427/13 6427/14 6428/1 6441/18 expert [2] 6396/7 6429/8 experts [1] 6464/20 explained [1] 6406/8 explains [1] 6437/24 explicit [1] 6463/18
discusses [1] 6414/24 discussion [2] 6475/21 6478/4 distance [2] 6462/12 6463/25 distributed [1] 6459/16 distribution [1] 6418/10 DISTRICT [4] 6392/1 6392/1 6392/11 6393/24 Divergence [1] 6417/6 divisions [1] 6454/19 document [25] 6406/2 6406/5 6409/21 6417/17 6420/15 6422/7 6432/21 6435/7 6438/21 6439/5 6439/9 6440/3 6441/16 6442/20 6445/9 6454/12 6454/13 6455/1 6455/4 6455/5 6456/24 6456/24 6458/3 6472/5 6474/20 documents [32] 6397/10 6399/16 6399/20 6399/23 6400/2 6400/9 6400/23 6404/7 6404/24 6404/25 6405/4 6405/13 6405/13 6406/11 6406/24 6406/25 6407/20 6408/3 6422/12 6422/13 6422/14 6428/11 6431/12 6445/20 6445/20 6450/22 6451/2 6451/4 6469/1 6472/4 6472/6 6472/25 DOJ [2] 6392/13 6476/8 dollar [1] 6446/20 dominant [11] 6415/3 6415/9 6415/10 6415/18 6415/22 6415/25 6417/20 6417/20 6418/3 6418/4 6418/11 done [13] 6406/22 6407/4 6427/7 6437/16 6458/19 6466/11 6466/16 6466/25 6467/4 6467/6 6468/6 6469/25 6477/14 down [20] 6397/13	down-talk [1] 6440/12 download [1] 6469/21 downloaded [1] 6461/13 Downloading [1] 6459/6 dozens [1] 6424/9 DR [1] 6464/8 Dr. [2] 6468/21 6473/20 Dr. Nayak [2] 6468/21 6473/20 drew [1] 6471/21 drilling [1] 6466/20 due [1] 6462/4 during [1] 6468/5 DX108 [2] 6406/5 6409/2 DX134 [1] 6439/6 DXD17 [1] 6403/16 DXD17-4 [1] 6403/16 DXD17.002 [1] 6399/12 DXD17.003 [1] 6423/9 DXD1705 [1] 6402/4	E e-mail [6] 6462/23 6463/12 6465/7 6465/17 6469/3 6477/9 earlier [6] 6401/22 6406/22 6418/16 6430/17 6448/17 6475/4 early [2] 6474/10 6475/21 easier [1] 6432/20 easy [2] 6427/15 6428/4 eaten [1] 6465/1 edit [1] 6453/25 edition [1] 6443/7 educational [1] 6413/25 effect [1] 6476/13 effective [2] 6443/22 6444/24 efficiencies [1] 6459/25		

E	features [13] 6401/22 6401/23 6402/1 6403/5 6408/9 6408/10 6408/12 6408/23 6469/14 6469/19 6470/11 6477/16 6478/10 fed [1] 6428/11 feedback [2] 6439/23 6440/1 feedforward [1] 6447/13 feel [1] 6454/13 feels [1] 6461/21 few [6] 6404/12 6408/4 6426/13 6441/3 6451/4 6451/6 fewer [2] 6405/13 6427/2 field [1] 6443/18 Fifth [1] 6392/17 figure [9] 6398/4 6404/14 6408/22 6411/13 6411/20 6427/1 6438/25 6470/12 6470/14 figured [1] 6471/22 figures [1] 6460/18 figuring [3] 6398/13 6400/3 6405/4 filed [1] 6467/25 fill [2] 6398/2 6398/5 final [2] 6430/23 6431/19 finally [3] 6408/25 6467/17 6473/6 financial [1] 6478/6 find [5] 6403/13 6420/18 6429/9 6467/6 6467/15 finding [1] 6459/8 findings [1] 6458/5 fine [3] 6432/3 6448/24 6474/11 fine-tuned [2] 6432/3 6448/24 finish [3] 6460/10 6474/8 6475/21 firm [1] 6477/24 firm's [1] 6477/23 firms [1] 6477/25 first [11] 6419/19 6420/16 6422/10 6422/11 6422/13 6436/1 6443/6 6456/19 6463/11 6469/4	6475/10 fit [1] 6404/4 F1 [1] 6393/11 flagged [1] 6474/20 Floor [1] 6393/4 flop [1] 6417/9 focus [1] 6464/18 focused [1] 6464/17 focusing [2] 6414/20 6457/7 folder [1] 6423/10 followed [1] 6421/13 Folly [8] 6458/12 6458/13 6461/10 6463/15 6463/18 6468/22 6468/22 6469/6 football [3] 6412/9 6412/11 6420/13 footnotes [1] 6457/8 For Plaintiffs [1] 6392/21 foregoing [1] 6479/4 forever [1] 6396/2 Forever's [2] 6396/4 6396/5 form [2] 6438/24 6443/6 forms [1] 6430/15 forth [7] 6422/16 6427/20 6445/15 6448/7 6464/19 6469/20 6473/1 forward [2] 6446/5 6475/4 found [2] 6457/19 6461/12 four [2] 6454/19 6456/3 fraction [3] 6418/11 6449/22 6449/24 frequency [2] 6417/21 6418/14 frequently [1] 6415/19 fresh [8] 6432/8 6449/2 6449/9 6449/13 6449/18 6449/25 6450/8 6450/17 fresher [2] 6450/6 6450/10 freshest [1] 6449/12 Friends [2] 6469/5 6469/8 front [2] 6410/14 6469/25 function [3] 6406/9 6438/8	6467/18 functions [2] 6438/20 6438/24 Fundamentally [1] 6469/9 further [6] 6415/19 6439/5 6441/16 6445/9 6468/13 6473/19	6461/1 6466/11 6473/23 6474/14 Goodrich [1] 6393/11 GOOGLE [91] Google's [11] 6396/18 6397/9 6428/8 6434/11 6446/1 6446/2 6451/21 6455/8 6457/14 6468/10 6478/1 Gotcha [1] 6428/6 grasp [1] 6441/4 great [3] 6471/4 6475/12 6476/5 greater [1] 6436/4 green [3] 6403/17 6403/21 6404/6 group [2] 6417/10 6469/4 groups [1] 6425/5 growth [1] 6441/18 guess [4] 6396/16 6416/14 6429/18 6461/6 guesstimate [1] 6447/19 guy [1] 6440/12	
F	fact [7] 6397/20 6415/14 6415/15 6448/4 6467/22 6470/10 6473/9 factor [11] 6403/19 6403/19 6404/9 6404/17 6404/18 6407/22 6432/25 6459/8 6461/2 6472/12 6477/2 factored [1] 6469/15 factors [16] 6403/20 6405/7 6446/14 6459/1 6459/22 6460/14 6461/7 6469/11 6470/5 6470/16 6472/9 6476/18 6476/19 6476/22 6477/5 6477/6 facts [1] 6445/18 fair [13] 6396/23 6397/21 6397/23 6398/3 6398/4 6398/7 6398/9 6403/20 6407/21 6409/18 6416/19 6416/24 6430/4 fairly [1] 6460/22 falls [1] 6427/23 familiar [3] 6413/16 6435/6 6467/22 family [1] 6443/7 fan [2] 6412/9 6412/11 farther [4] 6420/20 6443/14 6444/21 6453/4 fashion [1] 6475/17 fast [1] 6456/25 faster [7] 6456/13 6458/7 6458/10 6461/11 6462/4 6463/5 6470/2 favor [2] 6476/20 6476/22	fact [7] 6397/20 6415/14 6415/15 6448/4 6467/22 6470/10 6473/9 factor [11] 6403/19 6403/19 6404/9 6404/17 6404/18 6407/22 6432/25 6459/8 6461/2 6472/12 6477/2 factored [1] 6469/15 factors [16] 6403/20 6405/7 6446/14 6459/1 6459/22 6460/14 6461/7 6469/11 6470/5 6470/16 6472/9 6476/18 6476/19 6476/22 6477/5 6477/6 facts [1] 6445/18 fair [13] 6396/23 6397/21 6397/23 6398/3 6398/4 6398/7 6398/9 6403/20 6407/21 6409/18 6416/19 6416/24 6430/4 fairly [1] 6460/22 falls [1] 6427/23 familiar [3] 6413/16 6435/6 6467/22 family [1] 6443/7 fan [2] 6412/9 6412/11 farther [4] 6420/20 6443/14 6444/21 6453/4 fashion [1] 6475/17 fast [1] 6456/25 faster [7] 6456/13 6458/7 6458/10 6461/11 6462/4 6463/5 6470/2 favor [2] 6476/20 6476/22	fit [1] 6404/4 F1 [1] 6393/11 flagged [1] 6474/20 Floor [1] 6393/4 flop [1] 6417/9 focus [1] 6464/18 focused [1] 6464/17 focusing [2] 6414/20 6457/7 folder [1] 6423/10 followed [1] 6421/13 Folly [8] 6458/12 6458/13 6461/10 6463/15 6463/18 6468/22 6468/22 6469/6 football [3] 6412/9 6412/11 6420/13 footnotes [1] 6457/8 For Plaintiffs [1] 6392/21 foregoing [1] 6479/4 forever [1] 6396/2 Forever's [2] 6396/4 6396/5 form [2] 6438/24 6443/6 forms [1] 6430/15 forth [7] 6422/16 6427/20 6445/15 6448/7 6464/19 6469/20 6473/1 forward [2] 6446/5 6475/4 found [2] 6457/19 6461/12 four [2] 6454/19 6456/3 fraction [3] 6418/11 6449/22 6449/24 frequency [2] 6417/21 6418/14 frequently [1] 6415/19 fresh [8] 6432/8 6449/2 6449/9 6449/13 6449/18 6449/25 6450/8 6450/17 fresher [2] 6450/6 6450/10 freshest [1] 6449/12 Friends [2] 6469/5 6469/8 front [2] 6410/14 6469/25 function [3] 6406/9 6438/8	gains [1] 6443/17 gather [1] 6416/25 gathered [1] 6434/21 gave [4] 6409/3 6439/8 6454/11 6476/1 gears [1] 6453/21 general [12] 6419/2 6419/6 6424/15 6429/13 6435/4 6444/22 6444/24 6459/20 6470/18 6475/24 6477/6 6477/7 generalize [3] 6416/17 6439/1 6439/3 gets [8] 6401/3 6407/14 6407/17 6407/19 6408/8 6408/9 6408/14 6464/15 given [7] 6414/17 6424/16 6434/18 6442/3 6454/12 6471/7 6476/21 gives [4] 6400/20 6408/5 6443/16 6445/21 giving [2] 6408/22 6455/10 glad [1] 6454/7 global [1] 6434/1 glue [12] 6403/3 6403/4 6403/10 6403/20 6403/22 6403/25 6405/3 6408/8 6408/8 6408/13 6408/14 6408/22 goal [2] 6458/15 6458/18 goals [3] 6458/18 6463/18 6464/4 goes [6] 6399/13 6459/10 6459/25 6464/16 6464/23 6465/20 Gomes [2] 6465/14 6465/14 good [15] 6395/7 6395/16 6398/14 6406/20 6421/7 6426/12 6427/21 6445/12 6453/22 6458/23 6458/24	Goodrich [1] 6393/11 GOOGLE [91] Google's [11] 6396/18 6397/9 6428/8 6434/11 6446/1 6446/2 6451/21 6455/8 6457/14 6468/10 6478/1 Gotcha [1] 6428/6 grasp [1] 6441/4 great [3] 6471/4 6475/12 6476/5 greater [1] 6436/4 green [3] 6403/17 6403/21 6404/6 group [2] 6417/10 6469/4 groups [1] 6425/5 growth [1] 6441/18 guess [4] 6396/16 6416/14 6429/18 6461/6 guesstimate [1] 6447/19 guy [1] 6440/12
				H half [1] 6472/17 hand [1] 6454/14 handed [2] 6414/2 6414/3 hang [1] 6428/22 hanging [1] 6429/6 happen [1] 6470/15 happened [1] 6461/22 happening [1] 6450/16 happens [3] 6400/11 6404/5 6463/24 hard [7] 6438/9 6444/18 6452/21 6464/25 6470/15 6472/19 6473/2 hard-pressed [1] 6444/18 harder [1] 6447/16 hardware [2] 6459/21 6460/3 harm [2] 6477/3 6478/17 hate [1] 6440/11 hazard [1] 6396/16 head [1] 6463/18 heading [12] 6410/2 6415/3 6415/24 6439/19 6440/23 6443/2	

H	6468/18 6474/4 6474/13 6474/14 6475/19 6476/2 6476/8 6476/10 6478/20	6419/2 6419/6 6419/8 6470/2 6470/25 6472/5 6472/7 6472/11 6472/16 6472/20 6472/22 6473/1 6473/3	6398/15 6401/20 6405/20 6405/23 6410/18 6412/21 6412/22 6412/23 6413/1 6419/21 6419/23 6422/20 6427/19 6453/6 6467/6 6467/15 6472/9 6477/1 6477/8 6477/15	6394/16 6403/15 6404/7 6424/20 6435/18 6444/11 6451/24 6455/9 6458/1 6458/25 6459/1 6459/23 6461/7 6462/20 6465/12 6466/20 6470/5
heading... [6] 6455/16 6456/13 6457/4 6461/9 6462/2 6465/16	HONORABLE [1] 6392/10	imprecise [1] 6407/18	informed [1] 6446/4	inverted [1] 6406/14
heads [1] 6475/5	HOOK [3] 6393/23 6479/3 6479/10	impress [1] 6441/1	initial [2] 6399/20 6431/12	invest [1] 6427/5
heard [6] 6397/4 6397/6 6397/8 6468/22 6475/15 6477/25	hope [4] 6406/25 6429/18 6471/15 6474/3	improve [5] 6398/8 6459/23 6464/19 6464/21 6466/21	initially [1] 6432/13	invested [3] 6462/11 6462/15 6464/13
heart [1] 6464/16	Hopefully [1] 6475/16	improvement [1] 6441/20	input [1] 6476/17	investment [7] 6397/25 6398/1 6398/4 6459/11 6459/21 6460/3 6464/12
heavily [2] 6460/6 6460/8	hot [1] 6460/11	improvements [4] 6441/19 6464/5 6464/15 6465/2	inputs [4] 6408/16 6477/16 6478/14 6478/15	involved [5] 6400/5 6409/13 6409/15 6409/22 6459/19
heavy [2] 6459/6 6469/18	hour [1] 6453/24	improving [2] 6425/18 6470/12	insights [2] 6438/17 6439/3	IR [4] 6401/17 6401/20 6402/2 6472/9
held [1] 6398/20	hours [1] 6441/2	in-depth [1] 6413/21	instance [2] 6457/16 6464/11	is that [1] 6446/16
help [6] 6403/13 6403/18 6403/20 6404/3 6427/9 6474/6	https [1] 6470/4	included [1] 6402/9	instead [1] 6460/17	IS-scored [1] 6428/11
helped [1] 6395/4	HUANG [1] 6393/10	includes [2] 6403/4 6416/4	instituted [1] 6471/2	ISP [1] 6461/5
helpful [2] 6399/11 6422/17	Hubbard [1] 6476/18	including [2] 6477/16 6477/24	instituting [2] 6457/18 6458/13	issue [5] 6429/16 6457/13 6462/8 6475/9 6475/16
helpfulness [1] 6441/22	human [15] 6423/6 6423/20 6423/24 6423/25 6424/13 6425/13 6426/21 6426/23 6427/19 6428/25 6429/2 6432/6 6441/9 6446/7 6448/24	incomparable [1] 6470/17	intend [1] 6429/15	issued [3] 6405/16 6415/16 6456/3
helps [4] 6403/16 6404/2 6404/7 6404/9	humans [1] 6441/8	increase [1] 6398/10	intent [8] 6413/7 6415/20 6415/21 6415/23 6416/3 6417/6 6420/11 6429/17	issues [1] 6474/17
here's [2] 6425/7 6463/15	hundred [5] 6399/17 6399/18 6407/9 6408/4 6472/4	increased [1] 6398/16	intents [6] 6414/20 6415/3 6415/6 6415/9 6415/25 6417/11	item [1] 6474/18
Hey [1] 6465/19	hundreds [3] 6424/9 6431/22 6453/16	incurring [1] 6470/24	interact [1] 6422/15	items [2] 6436/22 6436/24
Hi [1] 6463/14	hypothetical [1] 6434/16	indeed [1] 6456/9	interactive [1] 6469/20	iterate [1] 6426/17
hierarchy [1] 6472/16	hypothetically [1] 6434/17	Indefinitely [1] 6396/6	interest [1] 6418/5	J
high [5] 6406/21 6441/12 6477/23 6478/10 6478/13	I	index [26] 6397/9 6397/10 6397/18 6397/19 6397/22 6397/24 6397/25 6398/6 6398/8 6398/10 6398/17 6398/24 6399/1 6406/9 6406/11 6406/12 6406/12 6406/14 6406/20 6407/2 6407/14 6445/20 6450/23 6450/23 6469/13 6472/25	intend [1] 6429/15	JavaScript [2] 6469/21 6469/23
high-level [3] 6477/23 6478/10 6478/13	idea [3] 6425/18 6427/20 6449/4	indexes [1] 6477/19	interested [2] 6424/24 6429/7	JEFF [3] 6393/23 6479/3 6479/10
higher [2] 6415/12 6418/10	identified [2] 6395/24 6451/5	indicate [2] 6418/2 6418/3	interesting [2] 6417/10 6445/13	JOHN [1] 6393/7
historical [1] 6460/16	identifies [1] 6451/4	individual [2] 6427/13 6427/14	interject [1] 6433/15	JONATHAN [1] 6393/2
historically [1] 6471/19	identifying [1] 6477/8	individuals [2] 6460/24 6460/25	interleaved [2] 6411/17 6411/18	JR [1] 6392/22
history [9] 6467/17 6467/20 6467/20 6467/23 6467/23 6467/25 6468/5 6468/7 6468/10	IL [1] 6392/20	industrial [2] 6416/8 6416/20	internal [4] 6477/9 6477/10 6478/1 6478/4	judge [2] 6392/11 6473/2
holds [1] 6398/10	images [6] 6459/4 6459/5 6459/6 6459/8 6464/21 6469/19	inferred [1] 6444/19	interrupt [5] 6406/6 6426/20 6427/9 6461/25 6472/15	jump [3] 6434/5 6442/15 6456/3
home [3] 6416/14 6416/16 6419/14	immediately [1] 6449/11	information [22] 6398/10 6398/13	intersect [1] 6407/2	June [2] 6458/5 6462/24
homework [2] 6416/9 6416/15	impact [1] 6410/7		intersecting [1] 6406/17	June 19th [1] 6462/24
Honestly [1] 6463/13	implement [1] 6425/21		into [22] 6394/11 6394/12 6394/13 6394/14 6394/15	June 2017 [1] 6458/5
Honor [26] 6395/4 6414/4 6432/16 6435/13 6435/19 6442/6 6442/15 6453/21 6453/25 6454/3 6454/24 6454/25 6455/11 6457/23 6462/17 6465/9 6468/13	implying [1] 6448/3			junk [2] 6398/2 6398/6

J	latency [57]	6474/2	6422/4 6422/9	M
Justice... [1]	6446/14 6446/19	led [1] 6409/14	6471/12 6471/14	machine [19]
6392/19	6452/20 6455/21	left [2] 6402/13	6471/18	6397/3 6397/4
K	6455/22 6457/8	6456/17	locations [1]	6397/7 6402/10
KAUFMANN [1]	6457/14 6458/14	Lehman [1]	6419/12	6404/10 6404/25
6393/3	6458/16 6458/18	6476/14	logs [2] 6396/8	6405/4 6407/10
keep [4] 6395/25	6458/22 6458/23	length [1]	6448/5	6427/17 6430/7
6398/5 6446/19	6458/24 6458/25	6430/14	long [14] 6395/21	6430/11 6430/12
6457/10	6459/7 6459/10	less [6] 6420/9	6396/4 6396/5	6430/15 6430/16
keeping [1]	6459/21 6460/1	6427/23 6437/15	6396/8 6402/17	6430/18 6443/11
6471/9	6460/4 6460/7	6449/9 6460/24	6406/19 6430/10	6449/7 6453/17
KENNETH [3]	6460/25 6462/2	6470/6	6436/3 6449/11	6469/14
6392/13 6393/8	6462/4 6462/8	level [6] 6402/9	6461/20 6461/23	machines [4]
6395/16	6462/12 6462/15	6428/8 6438/8	6461/24 6463/17	6460/7 6460/21
kept [2] 6435/25	6463/15 6463/19	6477/23 6478/10	6478/11	6460/21 6460/23
6449/8	6463/19 6464/4	6478/13	long-tail [1]	magnitude [1]
key [2] 6465/20	6464/15 6464/16	likely [4]	6436/3	6437/3
6466/1	6464/20 6464/23	6406/20 6416/13	longer [2]	mail [6] 6462/23
kick [1] 6412/12	6465/1 6465/4	6421/8 6427/23	6453/23 6456/7	6463/12 6465/7
kind [10] 6405/5	6467/3 6467/8	Lim [3] 6463/12	longest [1]	6465/17 6469/3
6415/9 6417/2	6467/10 6467/11	6463/12 6469/4	6430/6	6477/9
6422/19 6444/19	6468/21 6469/5	limit [1] 6437/25	look [13] 6404/11	main [2] 6419/24
6457/17 6459/10	6469/8 6469/9	limitations [2]	6408/2 6409/21	6431/1
6470/23 6470/23	6469/11 6469/15	6440/6 6440/11	6410/2 6424/13	Maine [1] 6393/9
6471/10	6469/16 6469/16	limits [1]	6425/6 6425/10	mainly [1] 6462/4
kinds [4] 6408/1	6469/22 6470/6	6448/21	6434/1 6446/10	maintain [3]
6416/17 6445/17	6470/13 6470/19	line [5] 6395/9	6447/11 6454/13	6395/20 6464/4
6448/5	6470/22 6470/23	6476/16 6476/16	6456/17 6464/13	6464/15
knowledge [17]	6470/23 6471/4	6476/17 6476/17	looked [6] 6406/2	makes [1] 6438/9
6428/24 6443/24	6471/7	line-by-line [2]	6409/10 6438/25	making [3] 6422/5
6444/6 6444/10	later [2] 6403/6	6476/16 6476/17	6452/16 6467/5	6470/19 6477/1
6444/18 6445/3	6404/1	links [1] 6444/5	6469/2	many [26] 6399/4
6445/7 6445/11	latest [2] 6443/7	list [4] 6406/16	looking [22]	6399/7 6404/24
6445/13 6445/16	6463/15	6406/17 6406/17	6405/3 6405/5	6410/25 6411/2
6445/19 6445/21	launch [2]	6476/11	6406/15 6413/13	6416/7 6416/7
6445/22 6447/21	6409/15 6470/24	lists [3] 6406/19	6413/13 6415/8	6416/20 6416/22
6448/1 6448/8	launched [2]	6407/2 6472/6	6419/12 6419/17	6416/22 6424/7
6471/17	6448/17 6470/22	literally [1]	6419/21 6420/15	6426/1 6426/19
knows [2] 6417/2	launches [1]	6433/17	6424/25 6425/13	6427/2 6427/21
6429/8	6446/3	little [10]	6428/24 6428/25	6434/17 6452/11
L	launching [2]	6418/22 6419/16	6429/10 6429/13	6459/1 6459/1
lab [2] 6462/3	6433/25 6434/1	6419/22 6420/5	6432/21 6438/17	6459/16 6469/11
6462/4	Law [1] 6393/3	6427/18 6428/3	6438/19 6450/22	6469/19 6469/19
lack [1] 6462/5	LAX [1] 6461/12	6443/14 6470/4	6458/6 6466/24	6470/5 6472/1
language [15]	layer [1] 6461/1	6473/2 6474/10	looks [6] 6421/7	6472/8
6436/12 6436/17	leads [1] 6436/19	live [6] 6411/9	6431/11 6442/21	map [5] 6419/12
6436/19 6443/18	learn [2] 6447/18	6411/12 6427/25	6447/10 6467/2	6419/15 6419/16
6443/23 6444/6	6447/20	6428/1 6446/7	6470/2	6419/19 6420/1
6444/8 6444/16	learned [3]	6446/8	loss [3] 6419/16	match [2] 6399/7
6444/24 6445/14	6444/13 6444/16	LLC [1] 6392/6	6419/20 6466/20	6406/11
6447/19 6448/19	6444/17	LLP [2] 6392/22	lot [16] 6397/4	matches [1]
6453/6	learning [32]	6393/8	6404/7 6405/3	6401/2
languages [1]	6397/3 6397/5	loaded [2] 6460/6	6405/13 6426/10	matching [2]
6431/25	6397/7 6399/24	6460/8	6427/15 6430/6	6399/1 6399/4
large [5] 6415/10	6400/3 6400/5	loading [3]	6430/7 6430/9	math [1] 6417/15
6439/20 6441/22	6400/17 6402/10	6456/23 6456/24	6439/1 6445/13	matter [3] 6438/7
6445/14 6453/18	6404/10 6404/25	6456/25	6445/16 6452/4	6471/12 6479/5
larger [2] 6420/1	6405/5 6407/11	local [3] 6413/13	6464/16 6470/9	mattered [1]
6452/11	6408/5 6430/7	6422/14 6422/18	6472/3	6471/18
LaSalle [1]	6430/11 6430/12	locale [4] 6412/4	lots [3] 6407/20	matters [3]
6392/19	6430/13 6430/14	6412/20 6412/22	6459/4 6460/20	6422/4 6471/14
last [3] 6442/13	6430/15 6430/16	6412/24	low [3] 6457/7	6477/7
6474/7 6476/11	6430/19 6431/1	locales [2]	6469/5 6469/8	may [20] 6395/11
latencies [1]	6431/8 6437/20	6420/11 6432/1	lower [6] 6418/12	6395/25 6404/11
6452/22	6438/3 6438/8	localization [2]	6458/22 6458/23	6421/20 6424/6
	6438/10 6443/5	6408/1 6472/13	6458/24 6458/25	6428/25 6429/9
	6443/11 6448/12	localized [1]	6460/12	6431/12 6435/8
	6453/17 6469/14	6421/18		6441/1 6441/2
	least [2] 6456/17	location [5]		

M	6405/23	6456/18 6457/20	6450/5 6450/6	6403/4 6475/7
may... [9]	memorizes [2]	6458/6 6461/5	6450/11 6450/15	6475/10 6477/12
6441/20 6450/8	6405/15 6405/20	6471/12 6471/19	6450/18 6451/4	named [1] 6420/18
6453/9 6455/3	mentioned [3]	mobile-dominant	6452/15 6452/18	names [2] 6477/9
6455/4 6460/5	6412/15 6472/23	[7] 6415/9	6456/4 6459/4	6477/10
6460/5 6475/9	6474/16	6415/10 6415/18	6459/5 6459/6	narrow [1]
6476/5	methods [1]	6415/22 6417/20	6459/7 6460/18	6460/22
maybe [15]	6430/16	6418/4 6418/11	6461/21 6462/14	nature [1]
6396/25 6397/11	metric [1] 6423/6	mode [1] 6411/16	6464/21 6464/22	6476/21
6404/22 6408/21	metrics [1]	model [15] 6409/9	6464/22 6464/23	navboost [54]
6425/2 6425/23	6441/1	6419/13 6420/2	6471/6 6478/15	6402/15 6402/17
6426/13 6429/5	Microsoft [7]	6433/23 6433/25	morning [4]	6402/22 6402/25
6436/24 6437/16	6396/11 6396/12	6434/1 6437/25	6430/14 6432/18	6403/4 6403/7
6454/22 6464/21	6397/2 6397/4	6447/9 6452/11	6475/15 6478/22	6403/16 6403/18
6464/21 6464/22	6397/6 6474/18	6452/15 6453/18	most [12] 6396/20	6403/20 6403/22
6472/4	6474/23	6473/9 6473/12	6400/2 6400/11	6404/5 6404/6
MEAGAN [1]	middle [6]	6473/13 6473/17	6417/10 6418/7	6404/13 6404/15
6392/16	6443/15 6443/21	models [16]	6426/12 6429/5	6404/17 6405/3
mean [35] 6398/12	6443/22 6444/2	6428/12 6431/1	6439/23 6451/1	6405/7 6405/15
6401/1 6402/18	6447/4 6469/3	6431/8 6445/14	6472/5 6472/7	6405/20 6405/23
6403/18 6410/25	might [18]	6447/12 6448/6	6473/1	6406/2 6406/9
6415/6 6416/24	6396/16 6396/24	6452/2 6452/10	move [1] 6412/10	6407/17 6407/19
6419/8 6421/20	6398/2 6402/23	6452/16 6452/20	Mr. [14] 6395/3	6407/21 6409/9
6422/21 6425/5	6407/20 6418/22	6452/25 6453/5	6465/14 6468/16	6409/18 6411/4
6426/20 6430/12	6420/4 6424/16	6453/17 6459/24	6474/2 6474/12	6412/19 6412/19
6430/20 6433/9	6429/4 6429/7	6473/15 6473/17	6474/16 6474/19	6412/20 6412/22
6435/8 6436/23	6429/9 6433/23	modest [2]	6474/20 6475/20	6413/1 6413/4
6437/14 6440/18	6438/18 6441/13	6444/25 6445/2	6476/1 6476/14	6413/12 6413/15
6441/10 6444/9	6441/15 6453/22	modifications [1]	6476/14 6476/15	6420/21 6420/22
6444/13 6445/11	6466/24 6475/25	6475/22	6478/3	6421/3 6421/4
6447/8 6449/11	milliseconds [6]	modules [2]	Mr. Cavanaugh [4]	6422/10 6422/16
6452/18 6452/25	6458/10 6461/14	6396/14 6428/12	6468/16 6474/2	6432/14 6438/22
6461/20 6461/25	6463/5 6463/9	moment [3] 6406/6	6474/16 6475/20	6438/23 6440/13
6463/19 6464/11	6463/19 6463/24	6422/2 6451/11	Mr. Cavanaugh's	6454/7 6471/22
6470/8 6472/3	minimize [2]	money [2] 6398/11	[1] 6474/19	6471/23 6472/1
6472/19 6472/24	6420/8 6472/21	6427/5	Mr. Dintzer [1]	6472/14 6472/16
meaning [1]	mining [6]	month [14] 6434/7	6395/3	6472/20 6473/3
6412/6	6438/11 6438/14	6434/7 6434/8	Mr. Gomes [1]	NAYAK [5] 6394/3
meaningfully [1]	6438/17 6438/20	6434/11 6434/14	6465/14	6395/14 6468/19
6415/12	6438/25 6439/3	6434/15 6434/18	Mr. Lehman [1]	6468/21 6473/20
meanings [1]	minute [1]	6434/18 6434/19	6476/14	nearly [1]
6421/18	6476/13	6434/21 6449/5	Mr. Roszak [2]	6447/20
means [8] 6403/19	minutes [2]	6449/5 6449/6	6476/15 6478/3	Nebraska [1]
6404/17 6413/4	6441/4 6454/1	6449/12	Mr. Schmidtlein	6392/22
6415/16 6419/4	misunderstood [2]	months [12]	[1] 6474/12	necessarily [4]
6433/17 6436/9	6419/1 6425/3	6405/21 6405/24	Mr. Sommer [1]	6398/2 6412/16
6441/23	mixture [1]	6410/21 6410/21	6476/1	6430/21 6464/20
meant [4] 6420/17	6417/20	6432/11 6432/17	Mr. Vallez [1]	need [24] 6398/4
6438/16 6438/21	ML [1] 6459/24	6433/16 6433/18	6474/20	6404/12 6404/24
6468/1	mobile [44]	6434/6 6434/24	Mr. Yoo [1]	6406/10 6414/17
measure [3]	6413/1 6413/7	6449/7 6449/10	6476/14	6422/6 6427/23
6428/8 6428/20	6414/18 6414/25	more [57] 6397/3	much [12] 6395/20	6430/5 6436/3
6434/25	6415/3 6415/9	6397/6 6397/25	6404/1 6405/5	6439/1 6445/17
measured [2]	6415/10 6415/10	6398/1 6398/11	6420/1 6434/21	6445/18 6445/23
6434/14 6450/21	6415/11 6415/15	6398/13 6404/12	6443/24 6453/23	6447/14 6449/23
measurement [2]	6415/15 6415/18	6404/24 6405/5	6469/20 6473/17	6452/20 6452/21
6434/8 6434/20	6415/19 6415/20	6415/15 6415/18	6473/20 6473/22	6452/22 6454/13
measuring [1]	6415/22 6417/3	6416/7 6416/12	6478/21	6455/3 6455/4
6450/19	6417/6 6417/11	6420/14 6428/2	multiple [1]	6459/17 6460/1
mechanism [3]	6417/20 6418/4	6429/10 6429/19	6434/16	6475/1
6406/15 6406/18	6418/5 6418/7	6429/21 6431/16	MUM [10] 6451/7	needed [1]
6407/1	6418/8 6418/10	6434/12 6434/13	6451/16 6452/11	6447/21
meet [3] 6395/17	6418/11 6419/5	6437/5 6437/17	6452/15 6453/1	needs [6] 6432/22
6395/18 6464/3	6419/10 6420/2	6437/17 6437/17	6453/5 6473/8	6444/5 6447/11
MEHTA [1] 6392/10	6420/10 6420/17	6441/19 6443/17	6473/9 6473/12	6449/1 6470/15
memorization [2]	6420/21 6420/22	6445/4 6446/23	6473/13	6474/24
6440/13 6440/18	6420/25 6421/4	6447/5 6447/12	N	network [5]
memorized [1]	6421/11 6456/16	6447/14 6447/15	name [5] 6395/16	6444/13 6461/4
	6456/16 6456/17	6449/7 6449/9		6461/6 6461/7

N	numbered [1] 6455/13	6406/24 6408/12 6469/25	6476/13	6451/18 6452/1
network... [1] 6469/18	numbers [8] 6418/1 6418/3 6423/23 6435/25 6436/1 6463/21 6464/1 6477/19	one [62] 6396/22 6398/12 6398/20 6399/13 6400/16 6401/14 6402/4 6402/6 6402/15 6403/3 6404/12 6408/13 6408/22 6408/24 6410/7 6410/24 6411/14 6411/18 6417/16 6420/24 6422/17 6423/13 6426/23 6426/24 6428/19 6430/4 6431/18 6438/23 6439/14 6439/16 6441/7 6442/8 6445/12 6446/23 6448/13 6448/13 6450/4 6454/19 6455/10 6456/3 6457/8 6458/9 6459/16 6460/9 6460/21 6460/22 6461/11 6461/17 6461/19 6462/8 6465/25 6469/1 6470/12 6472/2 6473/3 6474/5 6474/18 6474/20 6476/11 6476/20 6477/8 6477/23	ordering [5] 6411/18 6411/19 6425/24 6426/13 6472/20 organic [1] 6444/5 organization [1] 6454/20 organized [1] 6425/5 otherwise [3] 6432/23 6459/9 6477/11 out [15] 6398/4 6398/13 6400/4 6404/14 6405/4 6408/23 6411/13 6411/20 6427/1 6438/25 6447/11 6456/1 6460/18 6470/12 6470/14 output [2] 6424/13 6425/6 outright [1] 6461/21 outside [2] 6395/8 6421/8 outweigh [1] 6476/24 over [14] 6398/21 6417/9 6428/19 6433/18 6433/21 6437/15 6437/20 6438/7 6452/11 6461/5 6461/5 6465/20 6471/22 6472/4 overall [5] 6396/24 6398/16 6419/15 6466/19 6472/3 overlap [1] 6426/11 overlapped [1] 6419/4 oversimplification [1] 6444/10 Overview [1] 6410/2 own [3] 6439/20 6461/4 6461/7	6455/12 6455/13 6456/10 6457/3 6459/3 6459/5 6461/8 6463/1 6463/11 6464/23 6469/3 6469/10 6469/18 6469/20 6469/24 6472/11 6473/1 page 8075 [1] 6446/24 page X1723 [1] 6420/15 pages [13] 6399/1 6406/13 6406/20 6414/12 6454/12 6454/14 6455/1 6456/16 6456/17 6456/18 6459/4 6459/6 6477/18 paired [1] 6443/23 PANDURANG [3] 6394/3 6395/14 6468/19 paragraph [7] 6443/15 6443/21 6443/22 6444/3 6444/21 6447/4 6447/17 paragraphs [1] 6453/4 part [18] 6399/14 6400/3 6401/6 6412/3 6415/18 6421/24 6422/25 6431/8 6431/18 6436/16 6436/17 6444/14 6445/3 6445/7 6445/25 6446/2 6454/21 6461/9 particular [8] 6411/23 6413/22 6418/24 6422/8 6424/8 6429/12 6478/14 6478/15 particularly [1] 6478/11 parties [1] 6476/17 pass [1] 6468/13 past [12] 6398/17 6398/18 6398/21 6398/23 6405/15 6405/16 6405/21 6406/22 6424/20 6426/3 6467/4 6470/21 Patterson [1] 6392/22 Paul [2] 6475/11 6475/12 paying [1] 6446/15 peak [1] 6460/11 peaks [1] 6460/7 people [20]
network... [1] 6469/18	o'clock [2] 6442/13 6476/2	6406/24 6408/12 6469/25	6476/13	6451/18 6452/1
networks [1] 6447/13	object [1] 6455/3	one [62] 6396/22 6398/12 6398/20 6399/13 6400/16 6401/14 6402/4 6402/6 6402/15 6403/3 6404/12 6408/13 6408/22 6408/24 6410/7 6410/24 6411/14 6411/18 6417/16 6420/24 6422/17 6423/13 6426/23 6426/24 6428/19 6430/4 6431/18 6438/23 6439/14 6439/16 6441/7 6442/8 6445/12 6446/23 6448/13 6448/13 6450/4 6454/19 6455/10 6456/3 6457/8 6458/9 6459/16 6460/9 6460/21 6460/22 6461/11 6461/17 6461/19 6462/8 6465/25 6469/1 6470/12 6472/2 6473/3 6474/5 6474/18 6474/20 6476/11 6476/20 6477/8 6477/23	ordering [5] 6411/18 6411/19 6425/24 6426/13 6472/20 organic [1] 6444/5 organization [1] 6454/20 organized [1] 6425/5 otherwise [3] 6432/23 6459/9 6477/11 out [15] 6398/4 6398/13 6400/4 6404/14 6405/4 6408/23 6411/13 6411/20 6427/1 6438/25 6447/11 6456/1 6460/18 6470/12 6470/14 output [2] 6424/13 6425/6 outright [1] 6461/21 outside [2] 6395/8 6421/8 outweigh [1] 6476/24 over [14] 6398/21 6417/9 6428/19 6433/18 6433/21 6437/15 6437/20 6438/7 6452/11 6461/5 6461/5 6465/20 6471/22 6472/4 overall [5] 6396/24 6398/16 6419/15 6466/19 6472/3 overlap [1] 6426/11 overlapped [1] 6419/4 oversimplification [1] 6444/10 Overview [1] 6410/2 own [3] 6439/20 6461/4 6461/7	6455/12 6455/13 6456/10 6457/3 6459/3 6459/5 6461/8 6463/1 6463/11 6464/23 6469/3 6469/10 6469/18 6469/20 6469/24 6472/11 6473/1 page 8075 [1] 6446/24 page X1723 [1] 6420/15 pages [13] 6399/1 6406/13 6406/20 6414/12 6454/12 6454/14 6455/1 6456/16 6456/17 6456/18 6459/4 6459/6 6477/18 paired [1] 6443/23 PANDURANG [3] 6394/3 6395/14 6468/19 paragraph [7] 6443/15 6443/21 6443/22 6444/3 6444/21 6447/4 6447/17 paragraphs [1] 6453/4 part [18] 6399/14 6400/3 6401/6 6412/3 6415/18 6421/24 6422/25 6431/8 6431/18 6436/16 6436/17 6444/14 6445/3 6445/7 6445/25 6446/2 6454/21 6461/9 particular [8] 6411/23 6413/22 6418/24 6422/8 6424/8 6429/12 6478/14 6478/15 particularly [1] 6478/11 parties [1] 6476/17 pass [1] 6468/13 past [12] 6398/17 6398/18 6398/21 6398/23 6405/15 6405/16 6405/21 6406/22 6424/20 6426/3 6467/4 6470/21 Patterson [1] 6392/22 Paul [2] 6475/11 6475/12 paying [1] 6446/15 peak [1] 6460/11 peaks [1] 6460/7 people [20]
new [13] 6392/24 6393/12 6421/6 6421/7 6421/19 6422/6 6426/14 6426/15 6427/18 6432/10 6432/23 6453/4 6475/22	NW [3] 6392/14 6392/17 6393/24 NY [2] 6392/24 6393/12	one [62] 6396/22 6398/12 6398/20 6399/13 6400/16 6401/14 6402/4 6402/6 6402/15 6403/3 6404/12 6408/13 6408/22 6408/24 6410/7 6410/24 6411/14 6411/18 6417/16 6420/24 6422/17 6423/13 6426/23 6426/24 6428/19 6430/4 6431/18 6438/23 6439/14 6439/16 6441/7 6442/8 6445/12 6446/23 6448/13 6448/13 6450/4 6454/19 6455/10 6456/3 6457/8 6458/9 6459/16 6460/9 6460/21 6460/22 6461/11 6461/17 6461/19 6462/8 6465/25 6469/1 6470/12 6472/2 6473/3 6474/5 6474/18 6474/20 6476/11 6476/20 6477/8 6477/23	ordering [5] 6411/18 6411/19 6425/24 6426/13 6472/20 organic [1] 6444/5 organization [1] 6454/20 organized [1] 6425/5 otherwise [3] 6432/23 6459/9 6477/11 out [15] 6398/4 6398/13 6400/4 6404/14 6405/4 6408/23 6411/13 6411/20 6427/1 6438/25 6447/11 6456/1 6460/18 6470/12 6470/14 output [2] 6424/13 6425/6 outright [1] 6461/21 outside [2] 6395/8 6421/8 outweigh [1] 6476/24 over [14] 6398/21 6417/9 6428/19 6433/18 6433/21 6437/15 6437/20 6438/7 6452/11 6461/5 6461/5 6465/20 6471/22 6472/4 overall [5] 6396/24 6398/16 6419/15 6466/19 6472/3 overlap [1] 6426/11 overlapped [1] 6419/4 oversimplification [1] 6444/10 Overview [1] 6410/2 own [3] 6439/20 6461/4 6461/7	6451/18 6452/1 6455/12 6455/13 6456/10 6457/3 6459/3 6459/5 6461/8 6463/1 6463/11 6464/23 6469/3 6469/10 6469/18 6469/20 6469/24 6472/11 6473/1 page 8075 [1] 6446/24 page X1723 [1] 6420/15 pages [13] 6399/1 6406/13 6406/20 6414/12 6454/12 6454/14 6455/1 6456/16 6456/17 6456/18 6459/4 6459/6 6477/18 paired [1] 6443/23 PANDURANG [3] 6394/3 6395/14 6468/19 paragraph [7] 6443/15 6443/21 6443/22 6444/3 6444/21 6447/4 6447/17 paragraphs [1] 6453/4 part [18] 6399/14 6400/3 6401/6 6412/3 6415/18 6421/24 6422/25 6431/8 6431/18 6436/16 6436/17 6444/14 6445/3 6445/7 6445/25 6446/2 6454/21 6461/9 particular [8] 6411/23 6413/22 6418/24 6422/8 6424/8 6429/12 6478/14 6478/15 particularly [1] 6478/11 parties [1] 6476/17 pass [1] 6468/13 past [12] 6398/17 6398/18 6398/21 6398/23 6405/15 6405/16 6405/21 6406/22 6424/20 6426/3 6467/4 6470/21 Patterson [1] 6392/22 Paul [2] 6475/11 6475/12 paying [1] 6446/15 peak [1] 6460/11 peaks [1] 6460/7 people [20]
newsletter [5] 6413/17 6413/20 6414/8 6414/15 6442/21	o'clock [2] 6442/13 6476/2	one [62] 6396/22 6398/12 6398/20 6399/13 6400/16 6401/14 6402/4 6402/6 6402/15 6403/3 6404/12 6408/13 6408/22 6408/24 6410/7 6410/24 6411/14 6411/18 6417/16 6420/24 6422/17 6423/13 6426/23 6426/24 6428/19 6430/4 6431/18 6438/23 6439/14 6439/16 6441/7 6442/8 6445/12 6446/23 6448/13 6448/13 6450/4 6454/19 6455/10 6456/3 6457/8 6458/9 6459/16 6460/9 6460/21 6460/22 6461/11 6461/17 6461/19 6462/8 6465/25 6469/1 6470/12 6472/2 6473/3 6474/5 6474/18 6474/20 6476/11 6476/20 6477/8 6477/23	ordering [5] 6411/18 6411/19 6425/24 6426/13 6472/20 organic [1] 6444/5 organization [1] 6454/20 organized [1] 6425/5 otherwise [3] 6432/23 6459/9 6477/11 out [15] 6398/4 6398/13 6400/4 6404/14 6405/4 6408/23 6411/13 6411/20 6427/1 6438/25 6447/11 6456/1 6460/18 6470/12 6470/14 output [2] 6424/13 6425/6 outright [1] 6461/21 outside [2] 6395/8 6421/8 outweigh [1] 6476/24 over [14] 6398/21 6417/9 6428/19 6433/18 6433/21 6437/15 6437/20 6438/7 6452/11 6461/5 6461/5 6465/20 6471/22 6472/4 overall [5] 6396/24 6398/16 6419/15 6466/19 6472/3 overlap [1] 6426/11 overlapped [1] 6419/4 oversimplification [1] 6444/10 Overview [1] 6410/2 own [3] 6439/20 6461/4 6461/7	6451/18 6452/1 6455/12 6455/13 6456/10 6457/3 6459/3 6459/5 6461/8 6463/1 6463/11 6464/23 6469/3 6469/10 6469/18 6469/20 6469/24 6472/11 6473/1 page 8075 [1] 6446/24 page X1723 [1] 6420/15 pages [13] 6399/1 6406/13 6406/20 6414/12 6454/12 6454/14 6455/1 6456/16 6456/17 6456/18 6459/4 6459/6 6477/18 paired [1] 6443/23 PANDURANG [3] 6394/3 6395/14 6468/19 paragraph [7] 6443/15 6443/21 6443/22 6444/3 6444/21 6447/4 6447/17 paragraphs [1] 6453/4 part [18] 6399/14 6400/3 6401/6 6412/3 6415/18 6421/24 6422/25 6431/8 6431/18 6436/16 6436/17 6444/14 6445/3 6445/7 6445/25 6446/2 6454/21 6461/9 particular [8] 6411/23 6413/22 6418/24 6422/8 6424/8 6429/12 6478/14 6478/15 particularly [1] 6478/11 parties [1] 6476/17 pass [1] 6468/13 past [12] 6398/17 6398/18 6398/21 6398/23 6405/15 6405/16 6405/21 6406/22 6424/20 6426/3 6467/4 6470/21 Patterson [1] 6392/22 Paul [2] 6475/11 6475/12 paying [1] 6446/15 peak [1] 6460/11 peaks [1] 6460/7 people [20]
newsletters [1] 6413/21	objection [7] 6435/15 6442/11 6442/17 6451/22 6457/24 6462/18 6465/10	one [62] 6396/22 6398/12 6398/20 6399/13 6400/16 6401/14 6402/4 6402/6 6402/15 6403/3 6404/12 6408/13 6408/22 6408/24 6410/7 6410/24 6411/14 6411/18 6417/16 6420/24 6422/17 6423/13 6426/23 6426/24 6428/19 6430/4 6431/18 6438/23 6439/14 6439/16 6441/7 6442/8 6445/12 6446/23 6448/13 6448/13 6450/4 6454/19 6455/10 6456/3 6457/8 6458/9 6459/16 6460/9 6460/21 6460/22 6461/11 6461/17 6461/19 6462/8 6465/25 6469/1 6470/12 6472/2 6473/3 6474/5 6474/18 6474/20 6476/11 6476/20 6477/8 6477/23	ordering [5] 6411/18 6411/19 6425/24 6426/13 6472/20 organic [1] 6444/5 organization [1] 6454/20 organized [1] 6425/5 otherwise [3] 6432/23 6459/9 6477/11 out [15] 6398/4 6398/13 6400/4 6404/14 6405/4 6408/23 6411/13 6411/20 6427/1 6438/25 6447/11 6456/1 6460/18 6470/12 6470/14 output [2] 6424/13 6425/6 outright [1] 6461/21 outside [2] 6395/8 6421/8 outweigh [1] 6476/24 over [14] 6398/21 6417/9 6428/19 6433/18 6433/21 6437/15 6437/20 6438/7 6452/11 6461/5 6461/5 6465/20 6471/22 6472/4 overall [5] 6396/24 6398/16 6419/15 6466/19 6472/3 overlap [1] 6426/11 overlapped [1] 6419/4 oversimplification [1] 6444/10 Overview [1] 6410/2 own [3] 6439/20 6461/4 6461/7	6451/18 6452/1 6455/12 6455/13 6456/10 6457/3 6459/3 6459/5 6461/8 6463/1 6463/11 6464/23 6469/3 6469/10 6469/18 6469/20 6469/24 6472/11 6473/1 page 8075 [1] 6446/24 page X1723 [1] 6420/15 pages [13] 6399/1 6406/13 6406/20 6414/12 6454/12 6454/14 6455/1 6456/16 6456/17 6456/18 6459/4 6459/6 6477/18 paired [1] 6443/23 PANDURANG [3] 6394/3 6395/14 6468/19 paragraph [7] 6443/15 6443/21 6443/22 6444/3 6444/21 6447/4 6447/17 paragraphs [1] 6453/4 part [18] 6399/14 6400/3 6401/6 6412/3 6415/18 6421/24 6422/25 6431/8 6431/18 6436/16 6436/17 6444/14 6445/3 6445/7 6445/25 6446/2 6454/21 6461/9 particular [8] 6411/23 6413/22 6418/24 6422/8 6424/8 6429/12 6478/14 6478/15 particularly [1] 6478/11 parties [1] 6476/17 pass [1] 6468/13 past [12] 6398/17 6398/18 6398/21 6398/23 6405/15 6405/16 6405/21 6406/22 6424/20 6426/3 6467/4 6470/21 Patterson [1] 6392/22 Paul [2] 6475/11 6475/12 paying [1] 6446/15 peak [1] 6460/11 peaks [1] 6460/7 people [20]
next [22] 6407/6 6407/9 6411/8 6415/2 6415/24 6417/9 6437/1 6437/19 6438/10 6443/15 6443/16 6443/21 6445/3 6447/17 6454/1 6456/10 6457/3 6462/2 6464/8 6465/20 6475/6 6475/15	oblong [1] 6412/10 observed [1] 6461/10 obsolete [1] 6453/10 obviously [1] 6465/21 occur [5] 6415/14 6415/18 6417/21 6418/7 6418/8 occurred [1] 6433/21 occurrence [2] 6415/11 6418/12 occurs [1] 6406/13 October [1] 6392/5 of addressing [1] 6459/14 off [21] 6395/19 6402/13 6402/20 6409/17 6409/19 6417/19 6434/5 6435/3 6435/25 6448/14 6448/21 6467/20 6467/23 6468/1 6468/5 6468/7 6468/10 6470/19 6471/1 6472/23 6472/24 offer [8] 6435/13 6435/14 6442/6 6451/20 6454/24 6457/22 6462/16 6465/9 office [2]			

P	plenty [3] 6460/12 6472/22 6474/9	6465/20	6475/14	6466/5 6471/13 6471/18 6471/18
people... [20] 6411/9 6412/10 6416/12 6416/16 6417/1 6418/5 6420/11 6421/6 6421/7 6421/8 6425/6 6426/22 6427/15 6428/4 6441/18 6464/13 6467/6 6467/15 6468/4 6470/22	plus [2] 6398/22 6469/20	probably [7] 6397/1 6399/19 6417/10 6444/9 6453/24 6465/21 6476/20	pub [6] 6420/16 6420/18 6421/5 6421/5 6421/20 6422/7	query [36] 6398/25 6399/2 6399/5 6401/2 6406/10 6406/11 6406/16 6407/3 6412/6 6417/1 6424/1 6424/2 6424/3 6424/6 6424/7 6424/8 6425/8 6425/15 6425/22 6425/22 6429/16 6431/9 6432/12 6438/14 6441/3 6448/22 6450/10 6450/11 6450/12 6450/13 6461/12 6461/19 6461/22 6465/25 6466/11 6473/14
per [2] 6446/18 6449/6	point [8] 6395/20 6419/20 6421/17 6422/5 6430/20 6438/10 6461/1 6467/16	problem [5] 6447/16 6460/13 6460/14 6460/22 6464/13	public [3] 6477/1 6477/2 6477/11	question for [1] 6421/25
percent [7] 6417/15 6417/16 6418/18 6418/18 6456/20 6472/17 6472/17	policies [1] 6458/14	proceed [3] 6395/3 6439/16 6475/17	publish [1] 6413/20	quite [6] 6407/19 6430/3 6433/17 6450/1 6470/25 6471/22
percentage [2] 6418/14 6448/20	policy [3] 6468/7 6468/9 6468/10	proceedings [2] 6478/23 6479/5	pull [2] 6399/12 6404/7	
performance [2] 6428/20 6441/1	position [1] 6437/15	process [10] 6400/6 6400/11 6427/3 6427/7 6431/15 6459/15 6459/18 6471/6 6471/9 6472/18	pulled [1] 6419/24	
perhaps [2] 6472/5 6472/7	possible [6] 6396/8 6420/7 6428/4 6432/5 6443/24 6448/9	processes [1] 6458/14	push [3] 6459/3 6459/5 6475/23	
period [2] 6397/14 6433/21	possibly [1] 6429/16	produce [2] 6426/2 6470/7	put [9] 6395/20 6415/21 6416/25 6424/20 6424/20 6425/1 6425/2 6429/3 6432/17	
personalizing [1] 6429/11	post [4] 6451/14 6473/7 6475/13 6476/13	produced [1] 6455/2	puts [2] 6401/8 6410/14	
personally [1] 6477/8	postings [4] 6406/17 6406/17 6407/2 6472/6	product [6] 6421/24 6422/25 6464/3 6464/12 6477/23 6477/24	putting [1] 6408/19	
perspective [1] 6419/15	potential [3] 6453/5 6474/20 6477/2	production [2] 6473/13 6473/18	Q	R
phase [2] 6407/6 6407/10	pound [2] 6428/22 6429/6	professional [2] 6416/8 6416/20	QBST [1] 6440/13	raise [1] 6475/1
phone [2] 6419/24 6421/11	powerful [2] 6426/16 6453/9	program [1] 6463/18	QPS [1] 6452/22	raised [3] 6457/13 6457/17 6474/18
phrase [1] 6404/22	practices [2] 6459/18 6471/3	programming [1] 6477/17	qualifies [1] 6423/25	raising [1] 6461/17
picking [1] 6413/12	pre [1] 6439/20	progress [1] 6440/23	quality [20] 6398/8 6398/20 6406/21 6413/16 6423/18 6423/24 6423/25 6428/9 6441/13 6449/17 6454/21 6464/17 6465/1 6467/3 6470/7 6470/12 6470/20 6470/25 6472/11 6478/1	ran [1] 6409/8
picks [1] 6410/17	pre-training [1] 6439/20	Project [1] 6458/12	quarter [1] 6414/8	random [2] 6409/22 6410/5
picture [1] 6428/22	prediction [1] 6476/1	projects [3] 6458/13 6477/9 6477/10	queries [48] 6405/16 6405/21 6405/24 6415/3 6415/8 6415/10 6415/10 6415/23 6415/23 6415/25 6416/4 6416/7 6416/8 6416/9 6416/20 6416/22 6416/23 6416/25 6417/6 6417/12 6417/20 6418/4 6418/6 6418/7 6418/8 6418/9 6418/10 6418/11 6418/12 6418/14 6424/20 6425/8 6425/10 6431/25 6433/20 6434/12 6434/13 6434/18 6455/16 6455/20 6455/24 6456/2 6458/6 6466/1	range [1] 6402/23
piece [1] 6429/6	prefer [2] 6419/18 6421/10	prominently [1] 6471/22		rank [7] 6403/13 6406/21 6407/8 6408/1 6444/5 6472/18 6472/19
pieces [2] 6404/4 6408/20	preferences [1] 6447/22	proposals [2] 6476/18 6476/19		RankBrain [16] 6431/2 6431/11 6431/11 6431/15 6431/20 6431/22 6431/25 6432/5 6432/8 6432/11 6432/22 6436/2 6436/23 6437/10 6443/6 6447/13
pizza [4] 6412/14 6412/14 6412/15 6412/17	prepared [1] 6399/11	propose [1] 6475/21		ranked [2] 6426/8 6426/10
place [6] 6409/6 6412/17 6422/10 6424/19 6453/22 6467/15	present [3] 6401/6 6422/15 6473/24	proposed [4] 6474/22 6475/2 6475/22 6477/21		RankEmbed [15] 6400/6 6400/13 6400/15 6400/16 6400/23 6431/6 6443/7 6448/13 6448/15 6448/17 6448/17 6448/21 6449/17 6449/21 6451/4
places [1] 6467/5	presentation [3] 6435/9 6435/10 6474/1	proprietary [4] 6396/19 6396/20 6477/14 6477/20		ranking [28] 6400/1 6400/19 6404/19 6407/4 6407/10 6424/4 6425/19 6427/18 6430/24 6431/2
Plaintiff [1] 6393/2	pressed [1] 6444/18	pros [1] 6428/16		
plaintiffs [5] 6392/4 6392/13 6392/21 6471/21 6476/8	presumably [1] 6454/22	protections [1] 6437/25		
Platform [1] 6454/18	previous [2] 6449/20 6460/9	protocol [1] 6470/1		
platforms [2] 6454/15 6454/19	previously [2] 6476/14 6477/1	provide [3] 6422/19 6425/14 6434/16		
play [1] 6458/25	primary [1] 6428/8	provides [1] 6413/15		
please [3] 6406/5 6422/3 6451/12	principles [1] 6396/24	providing [1]		
	priorities [1]			

R	6405/21 6405/24 6455/5 receiving [1] 6398/25 recently [1] 6471/6 Recess [1] 6454/5 recipe [1] 6450/8 recognize [5] 6437/4 6437/6 6442/20 6458/3 6476/20 recollection [1] 6469/6 recommended [1] 6421/6 record [2] 6454/6 6479/5 recorded [1] 6395/22 redact [5] 6477/8 6478/2 6478/8 6478/9 6478/14 redacted [1] 6432/18 redactions [1] 6477/21 redirect [3] 6394/5 6468/16 6468/19 redo [1] 6400/24 reduce [10] 6411/3 6459/20 6460/3 6460/7 6460/25 6462/12 6463/19 6463/20 6465/1 6470/6 reducing [4] 6406/1 6409/8 6409/17 6462/15 reduction [2] 6409/5 6409/14 refer [1] 6430/20 refer to [1] 6430/20 referring [6] 6417/18 6417/24 6418/24 6422/22 6436/22 6466/17 refers [1] 6469/4 reflects [1] 6449/2 refresh [1] 6469/6 regions [1] 6421/9 regular [1] 6432/22 regularly [1] 6423/18 relate [1] 6476/25 related [5] 6416/8 6416/20 6436/21 6469/16 6477/4 relationship [1] 6406/8 relative [2]	6418/9 6437/3 relevance [2] 6443/17 6447/20 reliability [1] 6472/12 reliant [1] 6453/18 rely [1] 6447/19 remember [6] 6404/22 6406/12 6422/9 6457/13 6457/16 6457/18 remind [2] 6402/22 6465/18 removing [1] 6398/14 render [1] 6469/23 repeat [1] 6418/2 replace [1] 6437/10 Reporter [3] 6393/23 6393/23 6479/3 representation [2] 6429/4 6429/13 request [4] 6455/8 6460/10 6476/17 6476/24 requests [2] 6460/8 6476/23 require [5] 6427/18 6428/1 6428/3 6443/23 6444/25 required [1] 6447/15 requires [3] 6397/25 6398/1 6445/7 research [1] 6416/17 reserve [1] 6474/25 resolved [1] 6475/16 respect [2] 6462/8 6466/14 response [1] 6457/18 rest [1] 6460/20 restaurant [1] 6412/15 result [6] 6421/6 6456/19 6469/9 6469/11 6471/5 6478/16 results [47] 6399/4 6399/8 6401/12 6401/14 6401/17 6401/24 6403/7 6403/11 6403/23 6408/20 6411/17 6411/22 6412/3 6421/5 6424/2 6424/17 6425/10 6425/23 6425/24 6426/2 6426/3 6426/5	6426/13 6426/14 6426/15 6428/24 6429/1 6429/9 6429/11 6429/19 6429/24 6429/25 6431/23 6441/8 6458/7 6458/9 6459/2 6461/11 6463/5 6469/10 6469/13 6470/7 6470/20 6471/24 6472/12 6473/10 6477/24 retrained [2] 6432/8 6449/1 retraining [1] 6449/18 retrieval [10] 6400/6 6400/11 6400/14 6400/17 6401/20 6406/15 6406/18 6407/1 6451/5 6472/10 retrieve [10] 6399/1 6400/9 6406/11 6422/7 6422/8 6445/20 6445/21 6451/1 6471/24 6472/6 retrieved [4] 6406/24 6407/3 6408/10 6422/10 retrieving [1] 6472/4 returning [1] 6469/10 revealed [1] 6477/15 review [3] 6435/20 6455/6 6476/12 reviewed [1] 6455/1 right [154] ring [6] 6403/17 6403/17 6403/21 6403/21 6404/6 6404/8 risky [1] 6438/6 Rochester [6] 6421/5 6421/6 6421/7 6421/8 6421/19 6422/6 rocks [1] 6441/1 role [1] 6400/3 roll [1] 6448/14 rooms [1] 6467/23 root [1] 6412/10 rooting [1] 6412/12 Rosati [1] 6393/11 Roszak [2] 6476/15 6478/3 roughly [2] 6417/21 6418/15 round [1] 6412/12 rule [1] 6428/3 run [18] 6409/11	6411/25 6424/12 6424/17 6425/22 6427/15 6427/15 6427/17 6427/24 6431/15 6431/19 6431/22 6452/23 6460/11 6460/11 6473/12 6473/14 6473/17 running [10] 6424/15 6446/13 6452/2 6452/15 6452/19 6452/21 6459/23 6469/13 6469/23 6473/13
			S safe [1] 6476/3 SALLET [1] 6393/2 same [22] 6398/6 6402/25 6411/14 6417/12 6417/21 6418/4 6419/4 6420/12 6425/23 6428/16 6430/21 6432/13 6434/8 6434/10 6434/11 6435/3 6437/21 6448/5 6456/24 6463/8 6463/24 6464/1 samples [1] 6424/2 satisfied [2] 6421/8 6441/20 saying [5] 6398/19 6418/13 6418/15 6422/11 6450/1 scale [2] 6438/11 6452/21 scheme [2] 6411/6 6420/8 SCHMIDTLEIN [2] 6393/7 6474/12 school [2] 6416/9 6416/13 schoolwork [1] 6416/15 scope [1] 6474/21 score [16] 6399/24 6400/10 6401/3 6401/18 6402/1 6402/2 6402/3 6408/3 6423/2 6423/4 6425/15 6425/17 6426/6 6426/24 6430/24 6431/12 scored [4] 6401/17 6426/8 6428/11 6451/2 scores [4] 6399/21 6401/5 6441/12 6467/13 scoring [1] 6400/20 screen [4] 6402/7 6402/20 6419/24	

S	6443/22 6444/24	6399/17 6399/18	6473/17 6473/17	6456/20 6470/3
screen... [1]	6447/18 6471/8	6407/9 6409/8	single [1]	sorry [13]
6420/4	send [3] 6407/9	6409/11 6443/6	6426/24	6400/15 6406/6
scroll [1]	6426/4 6470/1	SGE [1] 6448/7	singular [2]	6410/4 6417/1
6419/16	sending [1]	shipping [1]	6453/18 6459/16	6421/14 6423/11
scrolling [2]	6469/17	6460/17	sister [1]	6427/9 6437/2
6419/22 6420/6	sends [1] 6460/19	shoes [1] 6429/3	6454/20	6442/8 6445/10
se [1] 6446/18	sense [9] 6429/15	show [2] 6419/19	site [1] 6421/10	6461/25 6472/15
sealing [2]	6436/13 6439/4	6435/9	situation [1]	6475/7
6475/2 6476/23	6447/15 6447/15	showed [1]	6426/12	sort [28] 6396/25
search [53]	6447/19 6450/9	6441/18	situations [2]	6404/2 6404/14
6395/21 6396/14	6472/16 6473/9	shown [6] 6401/15	6450/14 6450/17	6406/20 6406/22
6396/18 6401/12	sentence [3]	6411/12 6411/13	six [1] 6476/20	6410/13 6415/20
6401/22 6401/23	6443/16 6445/1	6411/14 6419/13	size [4] 6397/9	6417/21 6422/11
6405/10 6408/9	6464/8	6419/14	6397/16 6398/5	6434/7 6444/19
6408/10 6408/12	separate [4]	shows [1] 6403/14	6398/24	6446/22 6450/15
6408/20 6408/23	6436/17 6436/22	shutdown [1]	Sky [1] 6474/19	6459/18 6460/8
6413/16 6414/18	6436/24 6448/4	6465/19	slice [4] 6412/20	6460/12 6461/7
6414/19 6419/2	sequences [1]	shy [1] 6435/14	6412/22 6417/10	6465/18 6467/16
6419/6 6420/12	6447/10	side [26] 6410/10	6420/25	6470/9 6470/16
6421/24 6422/25	sequencing [1]	6410/10 6410/12	slices [5]	6472/9 6472/19
6423/18 6428/12	6405/11	6410/12 6410/18	6412/19 6412/20	6475/4 6477/6
6428/24 6429/1	SERP [8] 6401/9	6410/18 6411/24	6412/23 6413/1	6477/23 6478/9
6429/19 6429/24	6401/11 6401/15	6426/21 6426/21	6420/24	6478/12
6429/25 6435/4	6401/24 6403/14	6426/23 6426/23	slicing [1]	sorted [1]
6439/23 6441/19	6408/25 6459/25	6465/25 6466/4	6413/4	6406/21
6445/19 6446/1	6460/16	6466/4 6466/11	slide [1] 6435/21	sorts [2] 6401/5
6446/2 6448/12	serve [2] 6461/11	6466/11 6466/15	slides [1]	6428/2
6453/16 6454/15	6473/18	6466/15 6466/16	6423/12	sound [1] 6457/9
6454/18 6454/19	served [3] 6412/3	6466/16 6466/18	slightly [2]	sources [1]
6454/20 6454/20	6420/9 6422/9	6466/18 6469/12	6417/19 6420/9	6446/4
6458/7 6459/2	server [7]	6469/15 6470/7	slow [3] 6455/17	South [1] 6392/19
6459/3 6459/20	6411/16 6464/2	6470/10	6456/2 6473/14	Southern [1]
6459/23 6461/11	6464/12 6469/12	side-by-side [10]	slower [3] 6427/3	6421/19
6463/15 6465/16	6469/15 6470/7	6410/10 6410/12	6457/14 6457/19	speaking [1]
6469/10 6469/10	6470/10	6410/18 6426/21	slowly [1]	6477/11
6471/15 6477/18	server-side [1]	6426/23 6466/4	6449/17	special [1]
6477/19	6469/15	6466/11 6466/15	small [4] 6437/6	6473/16
searches [1]	servers [8]	6466/16 6466/18	6439/2 6449/21	specific [12]
6463/21	6459/21 6460/3	side-by-sides [1]	6449/24	6395/23 6397/11
searching [5]	6460/6 6460/8	6465/25	smaller [7]	6398/24 6420/22
6412/14 6416/12	6460/11 6460/23	sides [2] 6411/17	6399/23 6404/16	6439/20 6441/19
6417/1 6421/10	6460/25 6461/3	6465/25	6405/5 6407/8	6445/18 6452/10
6421/20	serves [1] 6458/7	sign [1] 6409/19	6449/6 6452/10	6457/16 6457/19
second [16]	serving [2]	signal [4] 6406/9	6473/15	6458/15 6458/17
6410/7 6420/4	6435/22 6473/10	6408/13 6408/14	SMURZYNSKI [2]	specifically [5]
6423/16 6436/1	session [2]	6413/15	6393/8 6394/5	6416/7 6420/14
6436/2 6439/18	6392/7 6474/5	signals [14]	so-called [1]	6458/6 6476/25
6440/22 6442/8	sessions [2]	6403/15 6407/8	6411/16	6477/3
6442/12 6442/25	6475/6 6476/14	6407/25 6408/1	software [1]	specifics [2]
6444/3 6452/22	set [27] 6399/15	6408/1 6408/2	6460/15	6420/3 6420/5
6455/13 6461/8	6399/23 6402/9	6408/16 6408/22	solution [1]	speed [1] 6469/18
6474/19 6475/18	6404/6 6404/11	6408/24 6472/1	6420/9	spend [1] 6398/11
secondary [1]	6404/13 6404/15	6472/3 6472/4	solving [1]	spending [1]
6419/23	6404/16 6405/5	6472/22 6473/3	6447/16	6470/6
seconds [2]	6407/8 6424/6	signed [1]	somebody [2]	SSL [1] 6462/5
6456/7 6461/13	6424/7 6424/8	6409/17	6396/21 6412/12	stack [4] 6396/14
secrets [2]	6425/8 6425/15	significance [1]	sometimes [6]	6404/1 6405/10
6477/20 6478/16	6425/16 6425/22	6472/18	6406/21 6417/11	6428/12
Section [1]	6425/22 6425/23	significant [1]	6420/4 6426/15	stand [1] 6468/22
6393/4	6425/23 6426/6	6443/16	6428/11 6428/15	standard [1]
secure [1] 6478/8	6426/8 6446/23	significantly [1]	somewhat [1]	6410/13
security [1]	6457/19 6458/13	6457/14	6434/13	stands [2]
6470/4	6458/18 6466/11	similar [1]	somewhere [1]	6401/20 6469/7
seeing [4]	sets [3] 6424/1	6467/6	6402/23	start [6] 6395/19
6427/20 6439/1	6424/3 6465/25	Similarly [1]	Sommer [1] 6476/1	6430/11 6431/11
6455/13 6456/23	seven [2] 6434/17	6478/3	Sonsini [1]	6449/17 6459/2
seems [5] 6441/17	6434/19	simple [1] 6399/7	6393/11	6460/10
	several [6]	simpler [2]	sooner [2]	started [4]

S	summary [2] 6458/5 6463/17	6440/9 6441/7 6443/12 6449/4 6451/7 6466/4 6467/2 6473/16	tested [1] 6426/23	tomorrow [4] 6474/1 6474/6 6475/1 6475/18
started... [4] 6430/14 6430/16 6432/13 6443/5	summit [3] 6454/15 6454/18 6454/21	talking [18] 6399/13 6402/10 6405/9 6417/13 6418/13 6418/19 6418/20 6420/14 6424/9 6433/17 6434/23 6434/24 6436/24 6448/2 6448/10 6463/8 6464/24 6473/7	testers [1] 6423/20	tongue [1] 6448/14
starting [2] 6397/24 6468/21	suppose [3] 6419/9 6419/9 6445/2	task [1] 6439/20	testified [2] 6397/12 6437/3	took [3] 6409/6 6420/1 6449/24
State [3] 6392/21 6392/22 6393/2	supposed [5] 6400/24 6418/1 6429/12 6463/20 6463/21	task-specific [1] 6439/20	testifying [1] 6418/16	tool [1] 6413/25
statement [3] 6397/2 6444/19 6450/4	sure [20] 6395/12 6406/7 6410/19 6421/13 6422/1 6422/14 6422/22 6425/4 6430/1 6436/24 6438/21 6444/1 6446/22 6453/3 6459/17 6464/25 6465/19 6470/20 6471/2 6474/7	taste [1] 6449/12	testimony [2] 6433/1 6473/21	tools [1] 6463/1
statements [1] 6477/23	surprised [1] 6409/11	Taylor [1] 6395/21	testing [3] 6466/4 6466/7 6466/14	top [21] 6408/4 6410/4 6414/14 6415/3 6415/6 6415/20 6415/25 6416/3 6419/14 6421/4 6421/15 6428/8 6431/12 6435/22 6437/9 6438/8 6452/1 6456/19 6460/19 6472/17 6472/17
STATES [4] 6392/1 6392/3 6392/11 6412/9	suspect [1] 6444/10	teacher [1] 6473/9	tests [1] 6423/24	topic [3] 6441/3 6441/4 6468/21
States' [1] 6474/21	SW [1] 6393/9	team [8] 6411/8 6454/20 6454/21 6454/22 6454/23 6459/16 6465/1 6466/20	Tetris [4] 6408/17 6408/18 6408/19 6408/23	topicality [2] 6407/25 6472/10
stay [1] 6443/15	Swift [1] 6395/21	teams [6] 6459/17 6459/17 6464/16 6464/19 6465/2 6471/7	thinking [2] 6460/23 6462/14	touches [1] 6441/7
steps [1] 6429/7	system [15] 6395/21 6400/7 6400/12 6400/20 6400/24 6405/15 6408/15 6424/12 6436/9 6438/7 6441/12 6444/5 6446/16 6448/12 6473/11	technical [1] 6413/22	third [6] 6414/8 6421/4 6440/12 6451/18 6452/1 6463/1	tracks [1] 6417/2
STEVEN [1] 6393/3	systems [23] 6396/19 6396/22 6400/3 6400/5 6400/17 6402/13 6402/15 6404/20 6407/23 6428/17 6430/18 6430/19 6438/8 6438/19 6439/23 6440/13 6443/8 6443/11 6446/1 6446/2 6450/22 6453/10 6477/16	technique [1] 6411/23	though [4] 6398/9 6437/15 6446/21 6450/5	trade [4] 6470/19 6471/1 6477/20 6478/16
still [8] 6398/8 6419/21 6437/24 6438/10 6446/23 6453/14 6453/19 6460/19	T	techniques [1] 6422/8	thought [3] 6477/19 6478/9 6478/15	trade-off [1] 6470/19
stop [1] 6470/24	table [2] 6415/19 6418/25	technology [2] 6478/10 6478/13	thousands [7] 6406/25 6407/5 6407/7 6407/15 6408/2 6431/23 6472/8	traditional [5] 6404/20 6438/11 6438/14 6450/22 6451/5
store [1] 6396/8	tackle [1] 6463/18	tend [1] 6427/15	three [10] 6398/17 6398/18 6398/21 6398/23 6409/21 6414/12 6431/1 6431/8 6434/9 6477/4	traditionally [1] 6438/18
storekeepers [1] 6422/18	tail [2] 6436/3 6463/19	tens [6] 6406/25 6407/5 6407/7 6407/15 6408/2 6472/8	three years [1] 6434/9	traffic [8] 6409/22 6410/5 6410/8 6446/8 6446/8 6449/22 6449/25 6460/6
straightforward [1] 6447/12	talk [3] 6426/21 6433/16 6440/12	terabytes [1] 6435/1	throughput [1] 6452/20	train [9] 6428/12 6428/16 6432/5 6433/23 6436/9 6447/14 6449/7 6449/10 6473/15
straining [1] 6440/23	talked [22] 6397/9 6398/25 6401/22 6406/1 6408/8 6409/5 6413/8 6418/17 6418/18 6421/23 6423/2 6430/13 6435/20 6440/6	terms [11] 6421/18 6446/13 6446/17 6459/7 6472/18 6473/8 6473/10 6474/1 6476/19 6477/10 6477/11	ties [1] 6443/17	train' [1] 6461/12
strategy [3] 6460/15 6460/16 6460/18	students [2] 6416/16 6416/18	terrific [2] 6442/18 6474/11	tightly [1] 6443/17	trained [12] 6405/18 6431/8 6431/25 6432/11 6432/22 6433/12 6445/15 6445/16 6448/4 6448/6 6448/21 6449/21
stream [1] 6424/2	structured [1] 6460/15	test [7] 6410/14 6410/18 6423/18 6423/25 6467/8 6467/10 6467/12	TikTok [3] 6467/7 6467/9 6467/13	training [13] 6411/4 6439/19 6439/20 6447/5 6447/9 6447/11 6447/12 6447/25 6449/1 6452/1 6452/9 6473/16 6477/17
streaming [2] 6460/18 6470/1	students [2] 6416/16 6416/18		times [8] 6422/19 6425/5 6434/17 6434/19 6456/3 6460/11 6466/24 6475/22	trains [2] 6436/3 6436/8
Street [3] 6392/14 6392/17 6392/19	studies [3] 6409/13 6446/8 6462/4		timing [1] 6474/6	transcript [2] 6392/10 6479/4
strengths [1] 6437/10	study [1] 6462/3		title [1] 6454/14	
structure [1] 6448/16	stuff [5] 6398/14 6403/13 6403/13 6422/19 6470/2		TL [1] 6464/8	
structured [1] 6460/15	sub [1] 6452/22		today [11] 6434/8 6437/21 6445/14 6448/6 6453/16 6458/7 6461/10 6474/24 6477/14 6477/25 6478/13	
students [2] 6416/16 6416/18	subject [3] 6413/22 6455/7 6477/7		together [6] 6403/13 6404/4 6408/3 6408/20 6410/14 6446/9	
studies [3] 6409/13 6446/8 6462/4	subset [2] 6433/24 6454/23		tolerating [1] 6470/19	
study [1] 6462/3	subsume [2] 6440/13 6440/18			
stuff [5] 6398/14 6403/13 6403/13 6422/19 6470/2	Suite [2] 6392/19 6392/23			
sub [1] 6452/22				
subject [3] 6413/22 6455/7 6477/7				
subset [2] 6433/24 6454/23				
subsume [2] 6440/13 6440/18				
Suite [2] 6392/19 6392/23				

T	U	UPX2034 [3]		
transcripts [1] 6477/15	U.S [6] 6392/14 6392/16 6392/19	6394/12 6451/9 6451/24	6399/1 6399/14 6407/10 6410/18 6431/1 6447/10 6448/12 6467/18 6471/23	6430/20 6430/23 6438/18 6459/8 6472/25
transform [1] 6453/5	6393/24 6433/24 6433/25	UPX680 [1] 6394/11	6471/23	weather [2] 6471/15 6471/15
transformer [2] 6447/11 6448/6	UK [1] 6412/11	UPX860 [4] 6433/14 6435/6 6435/16 6435/18	using [9] 6397/6 6407/1 6411/25 6428/16 6430/11 6430/14 6430/16 6443/5 6473/15	web [13] 6401/14 6401/17 6401/24 6403/7 6403/11 6403/23 6408/9 6408/11 6443/5 6445/14 6445/15 6445/17 6448/7
transformer-based [1] 6448/6	ultimately [1] 6403/14	usage [2] 6434/11 6437/5	usually [4] 6413/21 6415/11 6427/18 6476/5	Webb [1] 6392/22
transformers [1] 6447/10	unclear [1] 6435/14	use [19] 6399/19 6401/11 6402/7 6407/8 6411/21 6419/10 6419/12 6419/13 6424/3 6430/6 6438/18 6441/19 6448/11 6448/15 6449/7 6450/23 6472/1 6472/6 6473/18		website [2] 6422/18 6451/21
translate [1] 6441/13	under [11] 6400/11 6410/2 6436/2 6439/18 6441/2 6444/3 6461/8 6462/2 6462/2 6463/1 6471/8	used [20] 6397/3 6399/24 6401/6 6406/1 6408/17 6408/18 6409/9 6409/18 6412/19 6413/10 6428/11 6433/6 6433/10 6436/9 6438/18 6449/24 6465/15 6465/15 6470/21 6471/17	V	weekly [1] 6413/20
transport [2] 6461/1 6469/16	understands [2] 6436/3 6436/12	useful [2] 6422/21 6470/11	V-A-L-L-E-Z [1] 6475/8	welcome [3] 6395/2 6402/7 6454/15
travel [1] 6460/24	understood [6] 6396/25 6430/3 6434/3 6453/3 6467/25 6468/10	user [27] 6395/20 6405/18 6413/7 6414/20 6419/15 6421/2 6422/15 6422/21 6428/20 6429/3 6429/8 6429/12 6429/13 6429/17 6433/12 6433/16 6436/3 6439/23 6440/1 6447/21 6450/10 6450/10 6456/4 6461/2 6464/18 6464/19 6464/21	Vallez [2] 6474/20 6475/8	WENDY [2] 6393/10 6474/14
treated [1] 6478/12	unique [1] 6426/7	uses [10] 6397/4	valuable [6] 6450/1 6450/6 6450/11 6450/15 6450/18 6450/19	weren't [1] 6409/13
trees [1] 6430/15	unit [2] 6427/10 6434/7		variables [2] 6458/25 6472/17	what's [6] 6401/5 6406/8 6434/24 6445/21 6459/2 6475/10
TRIAL [1] 6392/10	UNITED [4] 6392/1 6392/3 6392/11 6412/9		various [5] 6406/14 6424/1 6428/2 6437/25 6471/9	whereas [2] 6420/17 6428/25
tried [1] 6470/21	unless [1] 6400/9		vast [1] 6447/20	wherever [1] 6397/24
trimmed [1] 6454/4	unlikely [1] 6429/5		versus [3] 6413/2 6456/25 6461/13	white [1] 6469/1
true [11] 6396/18 6403/15 6421/2 6421/22 6428/1 6429/10 6430/25 6435/5 6453/19 6460/5 6479/4	unreasonable [1] 6437/14		view [1] 6413/25	Who's [1] 6465/14
trust [1] 6438/4	up [27] 6399/12 6400/2 6400/23 6403/14 6408/13 6415/19 6419/24 6424/17 6430/10 6430/10 6434/11 6450/22 6454/14 6457/10 6457/14 6459/25 6460/8 6461/6 6462/3 6464/16 6464/23 6465/1 6469/25 6471/4 6474/21 6475/5 6475/25		visual [1] 6459/4	whole [8] 6421/17 6422/7 6425/15 6454/13 6454/22 6455/1 6455/10 6460/16
truth [1] 6473/12			volume [1] 6434/25	wholly [1] 6453/18
try [6] 6404/3 6404/13 6428/3 6430/2 6458/20 6462/12			vu [1] 6457/4	wifi [1] 6461/5
trying [4] 6423/23 6427/20 6439/2 6470/7			W	WILLIAM [1] 6392/22
tuned [2] 6432/3 6448/24			wait [2] 6431/19 6460/9	Williams [1] 6393/8
turkey [1] 6450/8			walk [2] 6406/18 6407/2	Wilson [1] 6393/11
turn [5] 6438/7 6467/15 6468/4 6472/23 6472/24			walking [1] 6406/16	wire [1] 6469/17
turning [2] 6422/24 6437/19			wander [1] 6395/8	within [2] 6446/19 6454/19
turns [2] 6447/11 6456/1			wants [2] 6410/14 6410/19	without [3] 6409/18 6409/20 6448/17
two [11] 6410/17 6411/17 6426/22 6436/16 6436/17 6453/4 6463/18 6474/1 6474/4 6474/16 6477/9			Washington [6] 6392/5 6392/15 6392/17 6393/9 6393/25 6471/16	witness [9] 6394/2 6468/14 6468/17 6473/24 6474/19 6474/20 6475/7 6475/8 6475/18
Tyler [1] 6392/22			WASZMER [2] 6393/10 6474/14	witnesses [4] 6474/2 6474/4 6474/16 6477/4
type [3] 6472/9 6472/10 6472/13			way [26] 6398/12 6398/14 6402/20 6402/22 6406/19 6406/20 6411/17 6418/6 6420/1 6422/6 6424/4 6426/16 6438/18 6441/9 6445/23 6450/19 6458/21 6459/14 6459/20 6460/14 6471/8 6472/21 6473/2 6474/22 6475/2 6478/12	wonderful [1] 6470/9
types [5] 6409/21 6410/4 6418/4 6446/10 6446/14			ways [6] 6424/1	word [5] 6406/13 6406/13 6412/6 6412/14 6412/20
typical [1] 6429/3				words [4] 6406/16
typically [3] 6399/4 6450/11 6460/10				
tzar [1] 6470/23				

W words... [3] 6407/3 6427/10 6473/1 work [23] 6396/23 6396/23 6400/24 6404/16 6408/5 6409/16 6416/4 6416/8 6416/13 6416/21 6450/22 6459/9 6459/24 6462/11 6464/22 6464/25 6469/12 6469/25 6470/15 6471/2 6471/8 6476/5 6477/16 worked [5] 6395/5 6396/11 6396/12 6396/14 6411/9 workers [1] 6416/25 working [4] 6396/22 6441/8 6460/19 6471/8 works [1] 6403/25 workstreams [2] 6464/3 6464/12 world [18] 6412/17 6423/21 6443/24 6444/6 6444/10 6444/18 6445/3 6445/7 6445/10 6445/13 6445/16 6445/19 6445/21 6445/22 6447/21 6448/1 6448/8 6453/7 worst [1] 6461/11 worth [2] 6432/12 6449/20 write [6] 6399/18 6452/1 6452/9 6466/10 6466/10 6466/19 writes [3] 6463/14 6465/17 6465/19 written [1] 6473/7 wrong [1] 6419/9 wrote [5] 6451/10 6451/14 6453/11 6453/13 6453/14	Yoo [1] 6476/14 York [7] 6392/24 6393/12 6421/6 6421/7 6421/19 6422/6 6475/22 you use [1] 6419/10 you were [1] 6418/19			
X X1721 [1] 6415/2 X1723 [1] 6420/15				
Y year [1] 6430/10 years [10] 6398/17 6398/18 6398/21 6398/23 6432/11 6434/9 6441/3 6443/6 6457/9 6467/4 yellow [1] 6457/9 yield [1] 6399/7	Z zero [1] 6439/9			