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Hello and thank you for standing by at this time all participants are in a listen only mode. During the question and answer session please press*one transcript question is conference recorded. If you have any objections you may disconnect at the start. I will turn the call over to Mr. Howard Wactler. You may begin.

Thank you. Good afternoon everyone. I am Howard Wactlar the division director for Information and Intelligent Systems. it is indeed a very special pleasure for me today to be able to introduce our guest, Deborah Estrin. Debbie has repeatedly demonstrated herself as a pioneer in in our discipline. She is a pioneer in the area of many senses. And has led to the boarding of the and SS I technology Center for embedded networked sensing.

[Indiscernible].

Okay. I guess I am not on. Okay. She is of course also pioneered in the area of what we call smart health, having engaged in the area of distributed sensors for gathering physiological and behavioral data on a continual basis and she will be telling us a bit more about that today. So check off. To it which you said pioneer. Smart health. And area three on mapping the educational goes out, I think she was the first external higher at the New York Cornell Tech Center. So we are pleased to see that she has made a move to meet and therefore she will be able to come with us at NSF in our panels much more often.

Noting, not just what I know but others have noted how successful in 2003 she received popular science interned and one of the brilliant 10 that year. So it is always nice when we get into the public blog press and they recognize what we are doing. In 2007, she received the Institute women division award of innovation. So she certainly has placed herself well in our discipline, had many a call to Schmitz and today she's going to tell us about some of her newest work.

Thank you very much. So people sometimes make fun of me for the amount of affection I have for NSF. I hope I know people understand that I am not pandering, but it started early on when I was in graduate school, my mother came here for a stint professionally. And it really was transformative for her. It makes me choke up because she has many years into dementia and she doesn't remember that she was here. That the poster that everyone gave her when she left is still up on the wall. It is a character of my mother with her running shoes on and it was a really special time after her having been somebody who was a woman on soft money for so years. And it was really a place they recognize her potential.

That popular science thing really in some ways happened because of NSF, in the sense that an SS and the opportunity to even think about some thing like an FTC caused me to think broadly to sort of I'm a technologist, I am an engineer, I am some times just pathologically aromatic. So I

don't really have a rich fantasy life. There is not a chance that something can actually material is, it does not drop me an.

Being able to think about an FTC and what it would take, what it was really, what it was worth -- what was with that investment on the part of the government, the NSF The tax dollars and the effort of people to come together and work hard to work together was to have a much broader vision is a technologist and that doesn't speak to the broader community. So I just really want to applaud, in between those of course there was NSF net. And everything that has a conversation going on the Internet among some of the old boys network on the Internet that includes some girls.

That whole transformative thing made the Internet really be allowed to go commercial but with analytics and so much of the world that NSF has had. So thank you for having me here. It means a lot to me. I want to talk to you about some newer work on what I have started calling the small data. But I will spend a lot of time talking about the work that led up to that and it is in the context of small data but I really see this as sort of a next new broadening as I will say more.

So I will talk about the work I have been doing in the context of mobile health that has a lot of overlap with the smart health programs here. Looking at it as this and equals media. So it is a play on words, a play on terms, where usually they are looking for large studies with large and for very good reasons because if you only have small and you do not how it is going to generalize or accommodated for that. But there is something really interesting that has emerged as an opportunity around individuals being able to have a better understanding of themselves over time.

Clinicians having better understanding of them over time and as often the Maybe teachers having a better understanding of their students over time and students of themselves or consumers of themselves, and really it is a little bit of a broadening of some of these rather edgy, sometimes odd movements that we look at like quantified self. But together with sort of a do-it-yourself mentality and a maker community that people can be the source of data and insight around themselves and also in the context of all that's been going on around behavioral economics and behavioral psychology. There is really sort of a coming together why this is a very rich time for looking at and equals me data, not in the narcissistic sense but in a productive sense that I will talk about.

So mobile health -- and this is an old sort of diagram of what I mean by it. Mobile health is the notion of taking a tagline that we started using AdSense we started talking about wireless sensing from the very beginning which was the whole notion of why was fired something new because you were turning things that were previously unmeasurable. You were making visible the previously invisible. You were making measurable previously unmeasured. And really what is different about mobile health and the smaller data. Is that we are taking previously unmeasured or at least unrecorded behaviors through practices and Through processing and analysis and mashing up and providing time contacts, turning that into personalized evidence-based and evidence producing care.

Overtime, this will help individuals take care of themselves in a better way and a more scientific manner way, help clinicians do better Ursulines care, and, overtime, contribute to the research evidence-based. So let me make it concrete. You have chronic back thing. From an injury or whatever it is. And you are prescribed a chronic pain medication. Chronic pain medication says, take as needed. You can try to take an anti-inflammatory as a lesser approach or you can try, not under got doctors guidance but under guidance of your friends or the web, an alternative approach. I am in one way a true California. I am at Californian when it comes to a broader notion of health and wellness. You might try a number of things or sell.

Friends or people on the web have recommended things. And that question of what is working for you? That is a very hard thing to actually track. Because nothing is probably going to eliminate the source of your back pain. So it is not about the sting or a headache that might completely disappear with an aspirin. It is going to be subtle improvements. It can be exacerbated by things that you do, heavy exertion, sleeping on travel without the standard K. You have lots of things that could exacerbated. So it is very difficult to do that scientific controlled experiment on yourself. How little of the chronic pain medication is opium-based can I take? When can I get by with the other? It is not a problem? You don't want to under consumer medication because you become sedentary and it has other of health problems and related problems. And you don't want to over consume because these things have addictive properties.

So the needed question of how we balance our life is one that now we live our lives digitally. There are ways that could be informed with real systematic evidence for you as an individual. The same comes in even more broadly in the way individuals do clinical peers, so micro finder of Open mHealth which I will mention my Ida Sim for the anti-as well as a PhD in biogenetics. When she is treating a patient, she has to have lab reports as they come in and she knows whether to what kind of medications if they're hoping their condition but a fair amount history history that you give where you are reporting on your symptoms and your side effects.

That is a balance thing. That has been underserved with concrete, objective, and temporarily high-resolution data. Finally, there are a whole bunch of things that you could go after clinician. You can ask them, if I do X will it help me with why? And their correct answer is, there is no evidence to support that. The answer there is no evidence to support that is actually factually true and means just that. There is no evidence to support it. It doesn't me know.

And the opportunity now to really understand a lot more from people's behavior and activities in the wilds from what we eat and drink to what supplements we buy or actually take from the Isle of whole foods, lots of things just aren't known because we don't have detailed data on the as it comes up in the context of some clinical study. Now we are starting to see some of this in the big data, Web mining and some of the opportunities there to go and dig down and understand correlations between things.

But this and equals me data is taking advantage that we live digitally and that we can have data feeding into these three feedback loops of health if you will. So you can take of it as a medicine, obviously a tremendous amount around big data, mining BEA jars and Web mining and all sorts of things where the more that this big aggregate of population scale data is out there We will be able to both discover as well as approve hypothesized correlation and causality.

And of course all the own mix that are so driven off of computation a support and I would offer and I'm not going to argue whether there are all the same height work with the pill is but another component there is the opportunity to actually have that feel typical and behavioral information from individuals.

So I am going to talk about lots of examples and lots of things. I think examples help for you to have in mind. They help for me to focus my narrative but also, in a constructive way, to focus your skepticism. In the sense that what am I talking about a high level more concretely. So have in mind things like independent living transitions. So independently then happens twice in our lives. It happens as we age and it also happens as we leave the home.

And in both of those there are times in context where a complete inability to have a sense of how somebody has, we no longer live in a village, relative we travel much farther from home base. Then we did in generations before. So how can technology play a role in filling some of the?

Auto immune and inflammatory diseases have fluctuations to them. When you've had chronic back pain and had small fluctuations but the condition is basically then you can make it much worse but it does not have inherent fluctuation. Autoimmune inflammatory diseases do. Rheumatoid arthritis, chrome, and that's they have players that occur and some are small times a year and you're trying to reduce their frequency and reduce their severity.

Having a technology and approach -- is this horrible acoustics that I am hearing or are you are you to?

UK you can hear me without this. You were being so polite. John, I understand why everyone was being polite but why were you being play?

[Indiscernible -- multiple speakers]

[Laughter]

Okay. When we have an opportunity to see continuous data from people From their functional behavior as I will say more Things in autoimmune and inflammatory diseases have a lot -- they are so under sample now. This is something that takes more step functions and we are going to end a clinical visit you are sort of sampling it in an appropriate frequency but auto immune is very understandable. Chronic pain is I mentioned because of how much is on the burden of the individual to do their own optimization and right now there's no blood test for perceived pain. So you can have the same physiological anatomical condition and you cannot determine, other than empirically from the person How much medication is going to help them continue to function in their everyday life.

So at some point as MRIs and things will uncover the secret of that as well but it is well quite a ways off. Mental health. Depression and how people are treated and prescribed for depression. There are many possible starting points for a clinician. They start with one that is always approved but there are many possible starting point as many of you are president and their

combinations of depression and anxiety. Some of the startup with a conservative does. And if none of these things, can instantly so the delay in the system, which is not exactly known, it is not 48 hours, it is it is not six-month. It is weeks to months and you have to wait for that to happen. To see whether you are treating it as an effective dose or whether you want to increase the dose or maybe there are some side effects that are going to cause you to come down even more. During that sampling time it is very hard because the a lot of things are happening and people fly. That could also shift their baseline of how they would self report and come in two month later and say is this an effective dose?

Particularly good things could be happening in them their life that change their level set or particularly not. So the opportunity to be much more continuously with somebody and understand and provide better or continuous data is huge enough space. Lastly, different from a research perspective but just a collaboration I am starting to enjoy in New York City is working with folks on the own mix inside. Who are really moving towards increasingly about launch a 20 moving towards increasingly about launch a 21 digital data and what is going on discussion, taboo pics and all those things that are not just the full genome. It is how your genes are expressing and looking at that can give an insight into disease mechanisms and a lot of these things that are not well understood such as the in Crohn's, and the source of things. When they are collecting much more frequent blood data to do that, they also need the data around your symptoms and side effects and they like to eventually be able to do a sampling where when you are actually starting towards a flare cut they have much more frequent biological data then when you are basically in a steady-state.

So there is a nice connection between those two.

Beyond help, there is really a lot of ways in life more generally that I think we will see the opportunity for some of the same small data to play in. So preventative financial help. What if when you went to make a significant purchase, -- you know you can have a setting on your e-mail. It let's you have a delayed by a couple of minutes before it actually gets sent. All those e-mails we wish we could have retired corrected we sent them out in some context. Financial health, if there is a small delay while the credit card is running and checking your credit, if you could see how that fits into your model and what it is going to do your credit rating. In some visceral way of connecting the immediate behavior to the longer-term behavior.

As an example. Scientific citizens -- I like to play with the word citizen science and a lot of what we try to do in STEMM through mobilized project with the school district that are contacts was try to bring participatory sensing and teaching of statistics to students in their everyday lives so that they could think and use data in their everyday lives. This is a way in which to think about the quantified self movement more broadly. The quantified students. So if students can start to engage in what made them successful on that particular unit, what was it that they were doing successfully to reinforce that success to try to created again? What aspect of trying to review were discussing with others fit their particular learning style? And it is a combination of both understanding or learning and helping to reinforce good behaviors.

Family applications and even things like personal profiles. So whether on your.-- on a dating website how you project yourself, rather than letting your data speak for you in a more authentic

way. You call yourself an active person. Some kind of profile of where you actually -- things that are quite personal. That is your distribution of your that you didn't spend your discretionary income on. Those of the sorts of profiles or gaming in terms of your avatar or your entity in a game might actually feed off behaviors you want to encourage in the real world.

In the context of health -- and I think that this can apply in other cases -- it really can have some profound potential to rephrase this data about ourselves can rephrase things like -- does it work? Or what works better than other? So if you just look -- what's

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If you just look at this in a medical context where the standard of creating evidence is to expose a collection of individuals with the right statistical properties to an exposure and look at the strength of the association with the outcome and we do these randomized controlled trials which we need to keep doing. I am not talking about RIT sees. Which we randomize for example individuals to run a medication versus another. The over versus a new farmer this one, one antidepressant to another, etc. We look at what works better. And this is a slide I borrowed from I can't college Ida, Ida Sim, as a said, a real doctor, and when she describes this, as she explains, -- when she sees results that show what medication is more effective in 75% of the population, it doesn't actually really tell her what to do the person sitting in front of her. If you are talking about different chemotherapies and surgeries and things that are not reversible, that is a much harder situation.

But there are many things that we are prescribed and that we do that are actually something we are going to medication that we are going to take for a long time, I blood pressure that it -- once you are on it you are supposed to be on it forever but at what does? And as newer Drudge drugs emerge switching over. So being able to put somebody on a medication, measure their symptoms and side effects can't go through a washout. Switch them over to the other, and identify which one is better for them.

Because we have data down at the individual level or virtually for free because we do not carry instruments around with this that are programmable had this sort of opportunity for changing the way we understand outcomes and treat people is a potential. And this can be true around learning styles as well.

So what are these data? Let me dig down a little bit to be a little bit more concrete. One very rich source of these data are just passively recorded activity and location traces from your phone. These things -- with or without if it consumer devices that people buy and which are good in some ways for other reasons because they remind you in that kind of visceral sense But a lot of that you can just run a in the background on your phone and we have been able to do this for a long time and now the new phone iPhone will be able to do it as well.

When you have a continuous activity location trace, there is a tremendous amount you can infer about an individual. Ginger I know is a really nice example of a startup company that has leveraged this start up out of a IT original. What ginger I know does For example in one of their context in which it is used They're looking at major depression and diabetes, diabetics who are depressed have significant problems with adherence, nonadherence. It can lead to very severe

side effects, as you a lack of management of your blood glucose has implications on your body and other organs.

So identifying those patients that are at risk for really going way out of it adherence and coming in with some support and help is very important in diabetes management and what they do if you run ginger on your phone It taps some aspect of your activity through the accelerometer and your location. By sampling that intermittently. As well as statistics from your medication. It establishes a baseline for you and it looks for variation from that. So we have a very rich machine learning engine in the back that is building the models because they have lots of individuals in their system but it is also building is about individual models for you as you subscribe.

So in a number of contacts they are looking at working alongside clinical systems to help do broader population management and focus early intervention for people whose nonadherence to prescription will really end up having severe medical consequences for them.

Mobile apps also generate data, so there are a lot of mobile apps out. And some of them are directly health related but more generally the apps we use and when we use them are also sources of data. Their sources of information. When you play your games with friends or angry birds, there is both that were when is it that you take those breaks? And there could also be How do you do? What is that vocabulary score on how you do when you're using words with friends under different conditions. How can that serve you as an individual, sort of looking at how your cognitive performance, whether it is with or without caffeine couple or goods sleep, stressed or not How can that feed in to be part of your personal analytics.?

And yes, of course there are real sensors to. There are particular devices designed to measure particular physic logical parameters. Some of them are quite medical related, whether this pulse ox or let Lucas, some of them more consumer related, some of them combined his consumer related devices like by the media can't really really important player recently purchased. Whether it is the range of at home whether wireless devices that you might connect the two met hub that is doing a number of different measurements, for people recently released from a hospital.

So these sensor streams are important. But I do not think they are more important. They're not more important than all those other streams that tell you about basic function. And it is not just about one data stream. To describe you and how you are responding and how you are doing, where you are in your disease state Is a more complex story than any one of those dimensions. So one of the quick point for Open mHealth as a nonprofit starting start up, is to create an open modular ecosystem because you do not want to have to go and download every app individually. Will that is okay. But in the end to bring a clinical picture, even a summary to you or your informal caregiver or loved one Let alone your clinicians. These things are going to have to come together and some coherent way that is easy to see. You might walk in with a bunch of links were a bunch of different Windows that you want your clinician to see but that is going to be a nonstarter.

There is no time in the clinical system for that. We have been exploring and working with the community to really take these disparate sources of data by having a standardized architecture

with standard API and encouraging the community to come together and focus not just on new sensor devices and new individual status streams but on making sense of those data streams over time and in combination. That is where a lot of the core challenges actually a.

Really transforming these few data streams into something that can be personalized and precise measures of a chronic disease. To do that, it is not a simple matter of a pretty picture or an anecdote. That's what I have here. Anecdotally, to make it concrete. I have been monitoring my activity and location for years. In the background. And you can see interesting maps of where you are going that may be a personal interest. They are comical -- it is another way of representing when you going travel. When I climbed Mount Fuji and I got to the bottom I was running one of these things. I sent an e-mail to my family with a geo-trace on the map of us hiking up Mount Fuji and the members of my family who opened the mail expected to see a photograph. But this is a different way of telling the story of what we've done.

That is true but it is very much -- those are ways of searching stores. You want to bring it into a clinical system. What is it about my location and activity patterns over time that are really going to be a clinical measure? Take rheumatoid arthritis. From that trace, the clinicians don't want to see a continuous trace they do not want to see high fuel count in my Nike plat. They do not want to see a number of steps. What they want to see is trending over time, what time of day for their patient, what time with the patient getting out of the house in the morning? Rheumatoid arthritis typically accompanied by morning stiffness. Not particularly understood why. But there when you are more in a proto-more a flare it is hard to get out of the house in the morning.

Hours spent out of the house. Minutes spent ambulatory Meeting just doing anything that is up and moving instead of sitting. Those are three derived measures from an activity location trace. They believe those can be relevant to giving you the feedback about whether a course of treatment is being effective or whether somebody might be entering a flare and you would rather intervene early because the longer you leave the flare untreated, the more steroids and things they have to take to bring it back down.

What is interesting about that story is that, as I work with people who do Crohn's disease for example, or IBS, some related symbols but very different physiologically They clinically ask their patients the same thing. When do you get out of the house in the morning? How much time do spend out of the house? That is a measure of the person's sense of safety that they are not going to have urgent needs which cause them to stay closer to home base when you have severe G.I. problems. So the opportunity to take the same underlying measures and convert them into things that are going to be robust markers for a particular condition, I think is where a lot of the interesting opportunities in relatively near-term actually live.

The same for depression. Some people spend a lot more time hold up when they are isolated when they pressed. Other people self medicate. They are actually out there more in that party mode. Many people as their depression is more severe have trouble with that behavior and giving themselves up and out of the house. So you are going to want to pull different derived values out of this location trace, in addition to increasingly being able to use other sources of data to feed into that as well.

I like to use the term of behavioral biomarkers. These are things -- if you can take a blood sample and of Jack Diddley and systematically and present per precisely derived, where somebody is in their disease state and they can do it with a finger prick in the way that people with diabetes do where does we will never be that. But there are so many things that we have no idea how to read in the blood. We cannot read it in the heart rate. We cannot read it in these other physical logical medals but we see it played out in people's behavior. Since our activities are so digitally-based now, the opportunity to almost for free -- once we figure out how to problem reply that Albury them, the incremental application of it is for free. This is a really significant scalable opportunity.

Some of the context in which this has more applicability. When we go to do that, we are at pretty young times in terms of figuring out what is this hierarchy of analysis yet with lots of commonality down at the bottom. These are just examples of the right kind of summarization and as you move up the stack you move to things that are more and more domain specific.

There is a lot of commonality in the overall -- it is similar to the way you think about speech, or vision or what have you and all these other fields. You use some common underlying constructs to do urinalysis. And then you start to do object or motion detection and then you start to do things very differently if what you are trying to do is some kind of robotic on the assembly line versus a surveillance camera.

So as we move up, we get to things that are more application-specific but there a lot of shared underlying approaches and I think that is where the field is now is the opportunity of creating what will hopefully be modular and usable techniques for this.

It is a good time to mention the whole issue of too much information, which plays both ways. So that expression of too much information that people often use as the recipient, like I really don't need to hear all that detail. From a clinician's perspective, it simply isn't actionable and they feel libel to actually listen to what you are saying there what information you say tell them they are supposed to use. When it is too much and it can't actually be fit into whatever amount of time they had a pattern with you just adds more noise to clarity. So we have to come up with these high-level summaries of what is going on and figure out what is a marker for rheumatoid arthritis, what is a good piece of data to use for a person's drugs are being titrated for depression. Or lupus or whatever that condition might be.

At the same time, there are all kinds of notions also on the consumer side -- that is just too much information to share. That can be -- sometimes people feel that way about their clinicians. Many people do not have a relationship with a clinician. They deal with the clinical system. It is employer-based or otherwise. That can feel like that is scary information to share with people in terms of where is my every moment location. And I think in this way Both usability by the clinical system and privacy on the part of the consumer are actually well aligned as opposed to at odds with one another.

Through this process of reduction of information but increasingly useful information You get to a kind of selective sharing that hopefully has a high information content for the clinician.

I've largely been using examples from over. That is where it really is a sweet spot place to be able to have a person be able to capture analytics about themselves. A lot of our communication is mediated this way. It is usually with us as we are out and about. It might or might not be how we make purchases. It is often what we do to entertain ourselves in between and at moments of downtime. And increasingly how people are consuming different kind of entertainment.

At the same time there are lots of things that we do that aren't mediated by this. So just to tell you a story, which is true how I got to this, I was in a sabbatical at the end of last year, and I received an e-mail from a woman I didn't know, hadn't met her, named Gert, living in Berkeley, and she had read an article in which I was quoted on some mobile health work in the New York Times.

She wrote me and said, it was interesting but I am 70 and my friends and I all have phones, we all have cell phones, but we're mostly on the Internet. We are not on Facebook. I lost my partner about a year ago, and I have a sense that if I would have have some way of keeping tabs on him and if I had been able to keep someone could take keep tabs on me, and she described it in are exchanged as in a belt and all is well. There was just some way that she could share with a small number them a friend and fellow. Eight belles all is well. We started calling it in our exchanger will be imposed. Let's just thing of it of it as a welding post.

That actually overlapped with -- did anyone actually listened to my to talk? Good. It is always embarrassing to tell the same joke twice. This is not a joke but you will see how horrible and off the cuff remark that was. It is never fun to tell the same story twice. So the story I told him I'd ted talk was not about. But at the time when I had this exchange it really resonated with me because I have lost my father earlier in the year and had this very intense several months -- I was at a meeting during one we had no idea what was going on I was at some smart meeting -- I was talking to them having no idea what was going on.

This exchange with her had me thinking about what might I have understood early about my father's condition from his digital traces? One of the first things I did notice that we noticed, is that he stopped responding to e-mail. For a 90-year-old man, you might roll your eyes and say, this is not so unusual. But my father was on the original ARPANET from the mid-70s. And he was not exactly digital the native but very habitual e-mail use user. It was very unusual for him.

That I noticed at the time. That was my sign. Something is wrong. But there were other things I had only thought about in retrospect because only in retrospect it I find out that he had stopped preparing food at home. My mother has dementia. He was her primary caregiver. He would prepare a meal a few times a week. Simple but he would. But he had stopped somehow not as a step function just gradually stopped buying food at the marketing prepare at home. All of their meals were eaten out or the leftovers from the restaurant.

Not them something he thought of telling anybody. Or that I thought of act asking. But unraveled as being clear in retrospect. His walks around the neighborhood -- he was a very determined habitual walker. His walks got smaller and smaller and began to get less frequent. Again, in retrospect it wasn't a step function. Back so when I thought about what Gert was describing, realized that my father having that kind of the well-being Polska would have taken in his loyalty

card at the supermarket that is datastream coming back from the supermarket, is location trace which could come from this and actually could conceptually come from AT&T and Verizon or whatever you're curious And his e-mail pattern trace.

It is not guys gnostic to say this is you are this way or you are that way. It would be a long time before we have that much going on in models like that. But more relative to your baseline. Relative to what a belles and all is well means for you. Noticing that something has declined. Had I known that, he would not have passed. It was his time. His cardiologist did not know what was going on until the very end. None of it showed up on in EKG. And even in the emergency room visit, I think two weeks before he passed away, the attending doctor had no information. No information that could tell him -- the man does look like a 90-year-old man. The attending doctor looked at me like what are you doing taking place in the emergency room? There are people that have been shot or been in car accidents. You have a 90-year-old father. Why are you wasting our time?

I have no really way of objective glee expressing him was behaving completely differently four weeks ago. He was still 90. So it is not that is necessarily about life or death but that management, us having the tools to indicate with a clinical teal team, even the tools for -- were things that are important people this. So that got me thinking. Newer technologies that I am about small data. I use the term small data because everyone is talking about big data as they should be. I am not trying to say it is about small data. They did a super important. But small data is also very powerful. You can think about small data being basically your row of their matrix.

Big enterprise for all their customers and users for each one of them and then they do big things over that. If it is your well. It is your trays from your cellular carrier, it is your loyalty card trace from your supermarket. Mobile carrier, it is your cable in talking to a vice president of time warner who does a lot of the cable facilities in New York City. She was saying that we collaborate on small data testbed in newer city. She said I might be able to finally show my father-in-law that he really is losing his hearing.

Just by looking at the digital trace of the volume control. That it is different than it was six months ago. He doesn't notice it because it is day to day and hour to hour but I can see it on the weeks or month and every month that I visit him. None of these are a killer app but it is just in combination, the opportunities -- whether you like it or not these digital data are there. If it bothers you, then my pathologically pragmatic side comes out and that is probably too late in terms of whether -- there is tremendous digital evidence and traces about each of us out there. As long as they're out there Can we get to them to use them in ways that are for us as well?

Not to the exclusion of them being used to smart meters from the early days of smart meters People talk about privacy on smart meters and privacy is one angle of what the smart meter might tell about me. If you if you're smart meter -- wherever there is a privacy concern a big data, there is an opportunity. Because if it is telling something about you can't maybe it could tell something about you to you. Or maybe it could be useful in some sort of way.

So the reduction in my father's cooking habit would have shown up in a smart meter signal as well. E-commerce. It is one of the ones that I made Lee's progress on some part but I am quite determined in terms of I think the thing that we have that -- most important for so many aspects of health and understanding the science and intervention has to do with the food we eat. It is so hard to measure. None of the approaches of journaling or taking pictures or any of those things are really sustainable by normal people. Maybe we will be able to get a little bit of a handle on it if we can start to get people's traces of transactions and purchasing of food.

Lots of other things from search, our state of mind, social media and e-mail Just wonderful opportunities for an LP over all the ways and places we use language. Through our texting and our e-mails and even our speech, which is increasingly digital, the opportunity to find patterns of speech use that can be our own personal indicator, smartcards, I don't think about that anymore because I don't have one and I am no longer in Los Angeles. I don't even get in taxes anymore for don't have to.

Games and music and entertainment. As I was saying, it is not just about health. It goes from health to well-being to consumption to family logistics. Can this be part of something that helps people create new habits around the family meal? Or shifts in the overall carb load in the family food budget. You can have a nap that computes your carbon, carbon load in your weekly food consumption budget. Carbon in terms of moving away from cards, carbon in terms of how far did the food travel. Something that appeal to -- I just thought of this. It is a horrible fun. This could appeal to both the greener and the leaner side of you. That is an important part of this whole division. Because the idea here is that we are not most of us quantified sufferers and are not going to be. We are too busy. Let us just leave it at that.

That is not where we focus. Just like most of us are not performance athletes. There are all these interesting behaviors we see out there but for the most part that is not who we are.

We are not going to get back our data and write some other code that goes and processes that or Python code or whatever it is to process our data and study. But we can create a new ecosystem of applications that run over it. So the model is that if I can get access to my data and really be the next nexus of my data stream So that I can, when I subscribe instead of all those different things and when I do my billing for my new cellular carrier I cannot didn't. They have an open API to your carrier and you can have your estimated activity location stream coming back from your mobile carrier to your -- wherever it is. Your personal databank that just as we wait different that is where we money can be in a credit union, could be in a commercial service.

There would be an ecosystem of apps that run over it to make it interesting. So just as with PHR's when you try to establish a PHR a personal health record, if you do not have apps that make that somehow interesting to the individual, it just has not gotten started. You need the data to automatically see. You can't have people entering things by hand. And you need the way in which those deed are made meaningful to an individual. Made meaningful because there's some form as an entertainment or made meaningful because it helps them achieve better health.

So part of this is the data liberation story. Todd Park really started that term in the whole open data initiative and his notion about liberating data. Get data out there so that people and

communities and companies can use it. It is the same thing here. Let individuals get access to their data in a programmatic, real-time, opting way.

You are not releasing their personal data to someone else. You are not violating the cable act because if you are a cable operator you cannot use that data for other things. But you can -- cable operator cannot. Because all you are doing is giving that data back to the individual. It is like giving them their billing data. You are not violating the common carriage act. You can be a carrier. You are not using the data for somebody else you do not have to anonymize it. The whole point is to not anonymize it. It is about you and the other data about you. Actually consumed. Both in fun and useful ways to support you.

I am excited about this space because I think it can fuel a new market of third-party apps and services, and also in a way that shifts a little bit some of our conversation about privacy. The value of actually seeing what is known about you is a big step in the direction of some balance in this conversation about privacy. I think what is disturbing to many people is to have things known that they don't know. When you know what is known, not through because you can go and submit a FOIA for your information act submission because what is known about you is informing your own apps. It is a utility in the apps that those things would give you and it is a balance even as we, to talk about some of the issues around privacy, which obviously other things have brought even more to life.

This is not easy so we have to get the data. Actually getting those he APIs getting open is have a lot to do with incentivizing the service providers and having them not feel afraid to do it. Not that I have full corporate commitment but I have some collaborative forming and I had a meeting with AT&T and Verizon and Time Warner and Ericsson and Intel and IBM and really, with quite interested exploit this kind of the space because there are revenue models out there down the line as well. American Express was there as well. So even some of these companies that are coming in with loyalty cards and mobile money providers. There was a value added that I think we can address that incentivizing issue.

But the technical challenges are all making sense of the data. Dealing with how noisy and biased and diverse these things are. And lots of opportunities from the lower level components of processing and natural language processing to the bigger model development of the individual. On this questions around privacy and data access and accountability, and actual building systems that we would trust to be such perpetually honeypots for important data and understanding of ourselves. From my early days as an Internet protocol person, I think it is clear that the way we do things best when it comes to applied computer science and information technology is by really taking that -- we did the first of those context. The whole notion of the minimal viable product in getting out to the field early and doing a lot of experimentation and piloting and prototyping to see where this can really take us.

One of the things that I am doing, as I just mentioned a moment ago, is working on creating research infrastructure in New York City which would be a testbed for small data. Data that we could use that as New York City is an interesting testbed for marketers and all sorts of things all over the world, it is an interesting opportunity to build a testbed of this kind where we can easily recruit people into all kinds of different pilots active personal data would come into the personal

data vault that we would develop started and machine learning tools that let us actually start to realize this vision of making use of small data.

So I just want to and with a couple minutes I have just to mention Cornell Tech, which was mentioned at the beginning. It is not in Ithaca. It is in Manhattan. It is a bluebird Bloomberg's extradition of creating an additional basis for the economy New York City. It will eventually be on Roosevelt Island. We will move there in around four years. In the meantime we had very generously been given rent-free space in the building that Google owns. We are not inside Google but we are one of their tenants who doesn't pay rent in the building. What is so exciting about the campus that is above and beyond it being in a very exciting city, is it is about a campus that really and braces and embeds external engagement.

So whether that is work with startups or with larger companies or work with nonprofits It is really attracting people who want to spend a lot of their time applying, so they do applied work or they do their theoretical work copout part of what drives their intellectual energy and their activities is spending time applying their work. Which gives you a really strong basis for actually engaging with the media and health and medicine and environment and education and nonprofit sector and foundation sectors that are there the city. So inexpensive the notion of research have, the initial one is being around a healthier life Built environment, and connected Beta. We are actively recruiting our next -- we started in January with the beta class. We have our first full class on our first of eight Masters programs. Masters students are the first and the first class citizen. PhD students are always important to us but they will be smaller another. We will not have full-time undergraduate degree programs.

So we are really trying to design us to be and to create a new kind of master students. Computer science and information science and computer engineering operations research Is a two-year program that will give you time to learn a vertical or a hub domain as well. So I wanted to be sure to get that advertised ties been out there. More about all of this is up on the web.

Okay. Thank you very much.

[Applause]

Questions?

All right?

You cannot do that to me.

What it is going to happen if I say yes to this?

Good question. We are just building accounts in that sense. Because some of this involves going to the service providers and saying there are really people out there who are interested in this. Going to Developers. Not necessarily right here but they were when in the car. At developers to say that there really people interested in this. So when there is a street artist and they want to start to build a crowd, you have to start by getting people around to start clapping their hands to build

a crowd. Just a little bit of that engaging interest. We will build our mailing list to be in touch with you about engaging in pilots and things like that.

[Indiscernible]'s back though.

Here are actually trying to understand the brain. Using SMR I and

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Yeah.

The reason why they're trying to understand the brain is to understand the behavior.

Right.

And what will the brain, in particular the maturing brain plays in the observable behavior.

Yes.

And I think that we cannot seek everybody for three times a year or whatever [Indiscernible] in the SMR are I since they were three years old. Several times a year.

That is intense.

[Indiscernible]. I think it is your approach that you are actually collecting data about observable behavior is somebody may be connected to all this other stuff but I think [Indiscernible]

Did anyone hear from as be [Indiscernible -- multiple speakers]

There is a good reason why people are not doing this but it has always seemed to me -- first it was with mobile and with small data. Somehow there is finally NMR FC for SP. In the somehow.

There is a huge role [Indiscernible -- low volume]

Yeah. But we need to go and start doing it. And we should do it in a way that is relatively open and modular so that we can have that role-play and I think there is -- I never thought after the and I would mention MR as see letters again. But yes.

How far away are we from actually seeing personalized data in forming -- information health there. On a personalized level?

It depends what meant -- I think -- I was talking with a company I want to mention. I will make an announcement fairly soon But I think the next wave of THR's that has more of the underlying pieces, actually it automatically injected with information and with the notion of apps or something that make it useful to the person, so both sides of what is needed to make the thing basically useful That will start to inform it. I think it is actually going to start happening that first way. How long it will take to ripple through? But that is not around all the ohmic stuck. The

ohmic discoveries are a little bit like in my previous life, like the transducers. The basic underlying center technology. They have a different -- it is a different timescale but it is an unbelievably hard problem and it will take lots of time for those things to emerge. So the really detailed actually knowing what our systems do and really be able to do precision medicine for it, that is something that will benefit incrementally as it goes. But the PHR side of it, I do not know. I am more optimistic than I was a couple of years ago.

Can I have some the?

Yes.

We have heard a lot about [Indiscernible -- low volume]. But we [Indiscernible -- low volume] and the monitoring of their activities and their behavior is extremely important in determining how well they are healing.

Yeah.

So it seems like now the new laws with respect to the health and the hospitals paying the cost of people that are returning will provide greater impetus for more of those systems and more attention to what the data says so they can stop and intervene before a person comes out the first of.

Is a really good point because one of the hard things here is that it is going to be monitoring everything forever and you are waiting to see some settled a client. That is going to be a long, hard problem. That here in the whole hospital readmission think it is a perfect time. It is an opportunity to monitor and have people improving at different rates.

You will learn about how that gets determined and you will be able to detect that something is done wrong. So it really is, not only from a cost perspective, important it is also a really good place to start to mature this approach and then it will trickle out.

I wonder how the problem of [Class is being polled] Globe for example your father? You would like to know because it is not so important [Indiscernible] it is but how can it be legally [Indiscernible -- multiple speakers] how is the information going to get to you

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Yes. And I think that comes up even without anything that I have talked about. Just read respect to the PHR's and a very good and important thing. Those are being set up now there is a newer wave of them. This question of food you give access to. You have your informal caregivers. And it might go from an assisted living context, or formal, people in the caregiving chain. But it may be people to your children or a neighbor things like that. So people are explicitly making sure that these personal health records have a place in an explicit moment in time and in which you decide who has access, who would get alerted, and some of these things are simply social choices that don't have anything particular to do with medical. He wasn't talking about something that had anything to do with her hospital or clinic. It was that if you can do all different kinds of Facebook ask, -- her version of her social network are these few people who she would -- they would like to have a non-imposing tabs on one other. So the medical staff I think people are on it

in terms of figuring it out. Some of these other things will come in through social media, particularly when we have more diversity in the underlying platforms of what makes for social media.

But sticky question from outside.

To ask a question, press*one. One moment.

At this time there are no questions on the phone line.

Okay. Thank you. Anyone else?

I was going to ask a question that regards policy. [Indiscernible -- low volume] medical records and this is an unintentional medical record so a socialized app. I was just thinking about the tallest the application of unintentional [Indiscernible -- low volume].

Some of them might not emerge as unintentional medical records. They might well emerge as a gateway for evidence in everyday life to come in in some processed way through the medical record which is then being used for clinical purposes and it is absolutely subject to hit but like everything else, just like the doctor would enter things from your clinical history. So in the doctor you enter things on your history. That is treated in the same way. Things that are really preclinical, the diary you keep, this kind of information What -- it is in the category of what the clinical we referred to as patient reported information. This is associated with all kinds of question is questionable bias and robustness. It is all true. When you have something that is offered in a non-engineered, monitored, regulated setting. It will be noisier. So until it is actually in the record, it is less about Cuba and it is more about being establishing doing lots of studies Quickly, to realize how to turn these noisy sources of data and under what conditions with what kind of information can you trust them. Can you trust them as a reliable source of information coming into the clinical care? So it is not that I think it means that because of association with medical, Erfurt therefore everything has to be governed by HNP PA.

I mean do other people have [Indiscernible -- low volume] would use it as if it were medical data but it is not covered by [Indiscernible -- low volume]

In the sense that -- with all these systems that we interact with because of the cell phones, the system operators have these data. Is that which would have been a?

Yeah.

Yes. So they in aggregate can be asked to sell them as additional data that Pharma or payers may might want to buy. And it is only happening. Until things are in the context of -- yes, this doesn't speak anything about that and it won't prevent it, nor will it explicitly add to it. I think that in every context, where there is a privacy concern The more we know about them and the more we can also turn those data to our advantage is all I am trying to bring into the picture. But you are right.

So [Indiscernible -- low volume]

Or your e-mail data with some good machine learning models but processing can be indicative of your health. So even when you'd do have the 23 me, it might actually not be deterministic about whether in fact you are at risk of earlier stage Alzheimer's or dementia. Maybe as we start to see with the language patterns had those early indications are there, and then those things really are relevant to not just employees. They are relevant here collects. The ones who choose user cofounder and what have you. So I think I did this to you even. When you started talking about sharing our genomic information. And I shut you down. I did it once before to air Corvus. I just think -- I am not one much for polite company because I'm not particularly play. The notion of in a social setting putting other people in a spot to report on what is their 23 is their 20 3M results tell about whether they had the genes for Alzheimer's, I just do not think it is the kind of thing that we should be putting on the spot to tell the stories.

Yeah.

Anything else? All right. Let's thank our speaker again.

[Applause]

[Event Concluded]