Dr. Gates: So the granularity can go to microseconds?

Dr. Pennington: It could be measuring microseconds, it could be measuring every ten minutes, it could be measuring once per hour, once per day.

Dr. Gates: So there’s an interval associated …

Dr. Pennington: Yes, Yes there is.

Dr. Gates: So when you talk about footprint, what would you all like to know about what a footprint is? You all know how to capture a footprint?

Student: For each different sensor, would we be able to access from the individual sensor data how big the foot print is depending on the time and the scale of the actual I guess area that is recording, or would we actually have to go and kind of find out ourselves?

Dr. Pennington: Well so, there is two different questions there. One if there is an inherit resolution set that is determined by the instrument itself, but then there is also things that the scientist can’t modify, so an instrument could be capable of measuring every microsecond, but I might only have it measuring once an hour, so those are two different things.

Dr. Gates: The footprint. What about the footprint? How do you know the location?

Dr. Pennington: Well it, let’s say you know the location, and usually, let’s come back to the camera there, I would have some sort of GPS reading about the location and now there is an error associated with that GPS reading, so I don’t really know where it is within certain error accuracy. Then I also know because of the instrument is going to be carrying information, metadata, about the instrument that will tell me what its spatial resolution is. That also has an error associated with it, and then there are other things that happen. So for instance, when you are measuring environmental things like humidity or temperature, or those sorts of things and you got an instrument that has a footprint say, you know, ten kilometers squared, but you got wind and wind impacts that measurement so it is not necessarily that ten meters turns in and gets warped and so now it shifted, and the instrument is no longer in the center of the footprint. So you are not necessarily measuring evenly around that footprint area, now the group peer has done a lot of search of mathematical models of how you try to understand that footprint, but not everybody has it and in fact that is one of the areas where we work with an intellectual contribution of this people have not taken into consideration. But so those properties we might be interested in being of able of specify the footprint, the actual footprint is different than what the calibration, the calibrated instrument would state.

Student: Would we be keeping track of the changing footprint?

Dr. Pennington: Well, let’s just say that the data could be used that way. I could envision that we could design properties that alerted us when say some wind condition happen, so that we would know that footprint is changing, so yeah I could see well-developed properties that will alert you about changes in your footprint.

Student: Is there only an algorithm that could be able to tell this wind is at this speed or some sort of changes, could you be able to tell footprint from those measurement will we have to manually go out there, so how would you able to do this?

Dr. Pennington: No yeah, you can mathematically calculate it.

Dr. Gates: Any other questions before we move on? I am learning something here. We always look at footprint, upper left, lower right from a satellite. So if you are looking at satellite data, it’s constant. There is a camera that you are looking at.

Dr. Pennington: But even there you have problems because we do satellite collections, well and if you think about a camera, it’s really its spatial accuracy is only correct good at what we call naitor?, the very center of the image and essentially if you go away from that, you are looking the camera sensors are looking at an angle, so that introduces distortion and error and some of them you can correct for that if you know lots of things. But it can also, a satellite image is going through clouds, so the radiation that you are measuring actually was the sensor is being reflected and refracted.

Dr. Gates: Is that part of the metadata? Is precision and accuracy included in metadata?

Dr. Pennington: It’s always included. There is always under lab conditions, sometimes you can calculate it and correct for it but some things like atmospheric correction it is really hard to do.

Student: Just a quick question, is it of any sort of importance to visualize where these sensors are like say in a map or some sort of thing?

Dr. Pennington: Absolutely, yep.

Student: Does the system have that right now, a way to see where the sensors are?

Dr. Pennington: No, it does not. It could be. I mean we know you can generate a map, but the system is not doing that right now.

Student: Every sensor has a fixed location anyway so it is just a matter of left right.

Dr. Pennington: Right. You could certainly put all that on a map and then maybe overlay information about the proper status of the properties or anomalies that have been stated, the data is there to do that, but is not doing it right now.

Dr. Gates: Now we are going to go into sensors and data. So, what kind of sensors will we have?

Dr. Pennington: You know, there is a wide variety that could be used. The commons ones are temperature, precipitation, humidity, soil moisture, and any of those could be measure it, any height above the ground, so you might be interested in ground stuff, you might be interest in ten meters above the ground, but those are the commons, CO2 levels of CO2, really just any chemical property that is out in the environment there is a sensor to measure it.

Dr. Gates: Reflectance data?

Dr. Pennington: Reflectance data absolutely, I mean well, I mean...

Dr. Gates: I am thinking just re-scope it right now and say these are the variables.

Dr. Pennington: You can try to calculate with a satellite use, you could take aerial photographs at different levels, or could be anything from space to ten meters off the ground. Dr. Tweedie has these kites and UABS that the uses, so he measures reflectance across the entire electromagnetic spectrum at all sorts of levels. I guess I maybe should explain what electromagnetic spectrum. So you have…

Dr. Gates: Start creating data dictionary. Hint hint.

Dr. Pennington: So light comes in from the sun it gets split, refracted and reflected into different ways and different wavelengths, it comes in at all sorts of wavelengths, but those things get reflected and refracted in different ways, depending on the composition of things that light hits, so your eye can detect certain wavelengths in that spectrum, but there are other wavelengths that your eye does not detect, both higher and lower, so radar for instance and thermal. Thermal is a radiation, a wavelength your eye doesn’t detect, but you feel it on the form of heat. So there’ s always spectrum. So everything, every material on earth responds differently to those wavelengths, so in satellite images or aerial photographs you can, satellite images in particular, but there are special tools that measure wavelengths beyond what your visible eye can see. So we might take a picture, but if we take a picture we only get a certain set of those wavelengths and with instrumentation we can measure these other wavelengths and those wavelengths can tell us something about what is happening in the environment.

Dr. Gates: Questions? Okay, so we have the types of sensors. Do these sensors have different data formats? Even within the same temperature, there would be different data formats depending on the instrumentation?

Dr. Pennington: Depends on, yeah, the instruments are developed by commercial industries and so each one has their own propriety format that they use. So yes, it can even though when you are measuring temperature, depending on what instrument you are using, you could have a different data format.

Dr. Gates: Is there documentation they could use to look at the formats or is that going be given?

Dr. Pennington: Well, the instrument itself has documentation provided by the vendor. In most cases what you want to do, I mean you will have to decide whether this is an assumption you want to make, but in most cases what you want to do is to take those propriety formats and convert them to something more standard like an ASCII text or some sort of binary format something that you could work with. I think you should assume that you are not going to try to work with every propriety format, that you are gonna convert the data first and do a common format that you could work on. What that common format is could be define by I mean certainly that current tool expects some sort of format, I don’t know what the format is, I didn’t do it.

Dr. Gates: So there’s a header file, right?

Dr. Pennington: Yes there will be a header file.

Dr. Gates: So there’s a header file and then the data in the header file will tell you a lot.

Dr. Pennington: The header file will tell a lot of that.

Dr. Gates: The header file will tell you what is stored, right?

Dr. Pennington: Right.

Dr. Gates: Is that clear everyone? What types of problems should be anticipated when it comes to describing different types of format and different collections of data? That might have been answered.

Dr. Pennington: Say that again.

Dr. Gates: Are there problems that we can anticipate because of these different types of format and different data collection?

Dr. Pennington: Well yeah I mean, I think I just answered that. You don’t want to work with the header G instated. You want to work on some sort of common format that you could work on.

Dr. Gates: So this question: does the system need to be able to define new file formats when new and better sensor instruments come out?

Now, we talked a little about this in an assumption that we are going to make. I don’t know if you want to talk about that.

Dr. Pennington: Well yeah, there’s always new sensors emerging and file formats change and that is true on satellite data, there is a whole history of satellite data and formats and they change. You know, obviously in order to use our system somehow we have to get the data into some sort of common format and that common format I assume is going to be defined by our system. So ultimately yes, there would be a lot of work for somebody to in order to use the system you should get the data into the format of the system expects.

Dr. Gates: So I think that we are going to agree that we will do a simulation. You are not going to be actually working with the actual instrument that is streaming the data. So we will be creating a file. They will be giving you files of the data as though real time [data is] coming in right? We will just simulate that process so we are going to assume that there is going to be a header file that is in a particular standard format. We will just make that assumption.

Dr. Pennington: So if you think about data streaming of all these sensors and you are going to assume that the data that you are getting has already been created and has already been transformed into whatever the common format is that you are gonna be using.

Dr. Gates: So whoever asked this question, whichever team asked this question—it is a good question because it helps you start scoping what the problem is, right? And what the expectations are. That was Team 1.

Okay, number 5, this is on the next page. How is sensor data going to be stored? Is there a database that can be used to make queries, reports? Or is the data kept in flat files on a file server?

Dr. Pennington: This one I sort of puzzled about because I’m not sure whether you are really asking about the sensor data itself or the data that the system we are designing collects about the sensor data. ‘Cause asking about the databases and that sort of things, yeah I mean we are gonna be giving to you this common format, but I don’t know whether it’s a database format or what that is. And your properties you’ll store those in a database or the anomaly information you can store that in a database, I would assume so, but the sensor data itself tends to be flat files as it comes off the sensors, but by the time you get it standardized in the way she is talking about, I don’t know what that would be.

Dr. Gates: So, does it make sense to you all? You’re the developers.

Student: Just to be clear, we’re gonna simulate all the data that we’re getting from the files and all that it’s gonna be real time, so we’re gonna simulate that being real time?

Dr. Gates: We’re going to simulate it being real time.

Student: when the sensors are sending off the data do they go through a third party first? And then you guys pull data from that third party?