ZETTA BYTES LIVE – Elliott Wolf of Lineage Logistics – July 15, 2020

Jocelyn Goldfein, Zetta Venture Partners: A warm welcome, and thank you for joining us for the very first Zetta Bytes Live. I'm your host, Jocelyn Goldfein and I'm so glad you're here. This is hosted by Zetta Venture Partners. We are a San Francisco-based VC firm. We write the first institutional check into AI for startups, with B2B business models, and we believe technology powered by data will reshape business as we know it.

Zetta Bytes Live is a new program organized around telling those stories. We'll feature deep dives into the state of the art in AI platforms and showcase industrial applications of AI with top industry leaders like today's guest. Elliott Wolf is vice president and chief data scientist of Lineage Logistics, the largest temperature-controlled warehouse owner and operator in the world. Approximately 80 billion pounds of food annually transit Lineage's 293 facilities, and *Fast Company* named Lineage number one in data science, and number 23 overall, in its 2019 rankings of the most innovative companies. Elliott holds a BS in Mathematics from Duke, an MS in Statistics from Stanford and a JD from Stanford. Elliott, thank you so much for joining us today. We've known each other for a couple of years. I'm going to ask you the question I couldn't quite hold back the first time we met. You've got an amazing background. You could have any job you want and data science or AI. Why on earth are you working for a food logistics?

Elliott Wolf, Lineage Logistics: It's kind of funny -- the normal paths into technology roles were just kind of defaults, like, Oh, you go to one of these things cause that's just what you do. This was much more of a deductive journey. If you look at the nature of the business, it's got all of the logistics complexities of an Amazon, plus you have to keep everything cold, which is an exercise in thermophysics. It's a super science-heavy business, just inherently. When I started there in 2013 -- I'm in the odd situation of having had the same job for seven years now -- no one was really working on it. And even today, I've got a team of about 12 people, but really we're the only ones kind of in this space. So it's been fun to make a difference.

JG: So I guess you kind of alluded to, this is a science problem, but what kinds of problems does a logistics company have that can be solved with math and with data? What kinds of expertise does your team need to have and what kinds of projects are you doing?

EW: The long and the short of it is: just imagine the food supply chain. You have got a basically multi-millennial effort, the entire history of humanity, geared towards figuring out how to feed itself. And the modern incarnation of that is a whole bunch of pooled infrastructure whereby almost no one that manufacturers food is actually responsible for the handling and distribution all the way down to the consumer. What instead happens is people go through facilities like

this. This is a rendering of a plant and we operate in Charleston, South Carolina. W have these things everywhere, and if you add our competitors, it’s basically close to food-producing regions and it's close to population centers.

So it is everywhere and ultimately it's storage capacity. And, basically, you would not have heard of Lineage Logistics. You probably would not have heard of our competitors. But you would have heard of our customers. This is eight tons of Sabra hummus sitting on a dock in Richmond. We do all the blasting for Chick-fil-A. If you're going to have a chicken sandwich, don't forget your 55 gallon drum of honey barbecue sauce. We handle most refrigerated meat exports out of U.S. ports. We even receive deadliest catch. This is a fishing trawler from the Bering Sea unloading at our facility at the port of Seattle. And now, to give it a long winded answer to your question, if you imagine the problems associated with this, the most important arguably part of cold storage is the cold.

You accomplish that by moving and controlling the temperature of air. That is an exercise in physics. This is a CFD simulation that we made of a blast cell that a person on my team named Alex Zhang designed. You could call this AI, you could call this data science, it's actually applied physics, but whatever, it's a giant high-dimensional gradient descent. And so if you know the mathematical methods to do AI/ML, then you also know how to do stuff like this. You've got your kind of classical supply chain graph theory problems. So these are all networks where food generally comes from, or let's just say there's many fewer locations where food is coming from than locations where it's going, and so high in the supply chain, close to the manufacturers, the farmers, the CPG companies is going to be relatively few sites. And then it's going to fractal out. It's going to go to regional distribution for four shipments across entire states. What this is showing is from those regional distribution centers, it's now going to the local distribution centers of the retailers.

So there's a time domain in which this is happening. You have to have sufficient frequency of shipments because this stuff is perishable. There are huge utilization complications whereby you've got a 90,000 pound gross weight, 18-wheeler tractor trailer. You're trying to utilize it. There's just all kinds of logistics, complexities. When you work in logistics, you have these crazy conversations: this was us thinking about renting an entire freight train. And we were trying to mine who was going in with meat from the Midwest into the Port of Long Beach, so that we could see whether the volume justified actually getting our own dedicated freight train.

There's a whole bunch of warehouse design questions. So for instance, the rack on the left is probably default in the supply chain. The rack on the right is what we build using reasonably advanced stats and common Metoric mathematics, where we're trying to predict the distribution of pallet sizes. These things vary seasonally, they vary by market. But you use a bunch of fancy stats to figure out a reference distribution that's safe. And then you use a bunch of fancy computer science to assign different height objects to various rack columns. And then

you go have a general contractor go build it for you. So the literal bin packing problem. So we actually physically been, we've been packed physical systems. Then I think the, the kind of Magnum Opus, at least of the common rhetoric and the statistics is now the robotic applications in warehousing with COVID supply chain resiliency is frankly trying to depend less on the humans.

EW: There are huge environmental and energy benefits from building robotic warehouses. They can be physically taller, so you need less concrete, you need less refrigeration. Um, and at least up until COVID, the labor market was really, really tight. And so as we're trying to schlep more food through the same assets, more food to feed a growing population, we'd like literally could not find the labor that we needed. Um, and then lastly, I think for, for your purposes, I'll touch on, um, probably what I think is the most interesting area of kind of classical AI/ML, Which is vision. This is a device that we developed with a startup, to identify labels on pallets. One of the main manual processes in the supply chain is saying, okay, this stuff is unloaded from a truck. What is it, how many cases are there are the day code square is this expired, is this damaged, and these are kind of classical vision applications. But then also we're using vision, mainly low compute, low profile, low power, um, innovations from quad copter drones in order to localize forklifts within facilities. And so we put little stairs…

JG: You're flying drones for the warehouse and repositioning forklifts based on what you see?

EW: No. So we, we took the compute package off of a drone that could fly around the warehouse and then just duct taped it to a forklift. And it tells us all kinds of interesting things.

JG: I'll stop there. I love that.

EW: That's kind of a high level overview of our problem set.

JG: So when I talked to it leaders at Fortune 500 companies, it seems that very often the problems with adopting AI are not technology problems, per se. It's not lack of expertise or resources. It's really kind of, um, you know, a lack of, of maybe a cultural leaning towards innovation or change when you first started in your job was data science value. Did like, did your management team understand what the value was?

EW: The now semi-famous quote from the chairman of the company, separately for my boss, the CIO of the company was, Hey, we hear those math and logistics. Will you come take a look? I mean, that was like the, the level of the marching orders.

JG: So you had a lot of blue ocean…

EW: Right. I mean, there's certain fundamental, um, there's certain fundamental kind of observations here. The first is that when you're hired into a position like that, your overlords are hiring you precisely because you're supposed to know more about what's possible than them. And so, um, you need from the very beginning kind of mutual trust, and the agreement was, if you don't want us here, if you don't want me here at the time alone, then I don't want to be here because if you don't want me here, then it means we can't make a difference together. So, um, fire me when you're, when, as soon as you want to, but until then we start out with maximum trust capital because there's going to be a whole lot of stuff. That's going to come out of the mathematical AI/ML realm that you're just not gonna understand, and you're not going to know the value of, and you're just going to have to trust that this is going to be good.

Now, I reciprocated that trust, in the very beginning, by putting everything in kind of tautological business terms. And so one of the very first applications that we deployed was actually this designing of the warehouse racks for increased density. And so it's like, well, what can, what can math do for you? It's like, we'll build warehouse space. And that's a pretty fundamental, that's a pretty fundamental economic driver, um, in the industry, especially when you're paying a $300 a square foot on refrigerator construction, and having to buy land and then having to spend millions of dollars a year, keeping it at zero Fahrenheit. If you can just change the pegs on your Ikea bookshelf, according to what your mathematician said and achieve the same thing, that's pretty fundamental. And that's probably a good illustration of how we operate. The objective is crystal clear and no one can disagree with it. The actual mechanics of it are opaque to someone who hasn't gone to graduate school in math or statistics.

JG: It sounds like you got some points on the board right away. Like you showed them the money kind of right out the gate. How long did that first project like that, that the maximum trust thing is a, is a bull approach. I mean, I think there's probably a lot of people on the call who are either entrepreneurs who are trying to sell the enterprises or who were working inside in Nevada enterprise is trying to innovate like you are. And I'm sure they're sort of taking this story to heart, but like how long did you have before you showed them?

EW: So we got some quick wins within about four to five months. But I had actually been very careful to negotiate at the beginning that this would take time. And the thing that took time was not so much getting the wins. It was learning the business. I mean, um, I had a background in private equity -- Lineage is a very large levered buyout -- so I knew those, um, those kinds of economic drivers, but I never worked in logistics before. I wanted to be respectful of the knowledge that the operators out in the field. So I spent three or four months on the road, traveling, meeting people, learning the business. And there are certain people in the company who can take credit for teaching me warehousing. It's hard, it's complicated.

JG: This reminds me of something I always look for in a founding team, which is that you need people who deeply understand the technology. You can't just like farm it out. Because this stuff is cutting edge, but at the same time, you also need people who deeply understand the domain. I think it's always been true in technology, but for data in particular, it's so easy to fool yourself and think it means something different than it does if you're not deeply grounded

EW: And even even today, the posture that we take is I think correct to the circumstances it's literally true is that we know more about math and physics than our operators do our operators know more about warehousing than we do. And that makes for a great collaboration, like members on a team that makes perfect sense. Hold hands, put more in the box.

JG: That's right. Okay. So we're 15 minutes in. We got to talk about, COVID-19 forget about AI for a second. When that hit, what was that like? How did, how did things shake out over the first 30, 60 days? I mean, we're all getting groceries just fine now, but I feel like at the beginning we were all, you know, panic buying pasta and trying to figure out if we would run out of food.

EW: Let me give some kind of context here. So first COVID happens. There's kinda two failure modes associated with the supply chain. Th first is that you now have what effectively is unavailability of labor. You're trying to immediately start to social distance stat, effectively hamstrings, your throughput capacity. You have to, you might have employees who are very concerned about how to, how to stay safe in that environment. And so you effectively have to handicap your labor throughput. And then the second failure mode is that you now have a tidal wave of volume that needs to go out. And you've got people, panic, buying people, freaking out. People are basically making an assumption that the stuff is not going to be available and therefore buying loads of pasta or loads of whatever.

The good news though, was that those failure modes are not alien to us. So one of we've had labor shortages for years, especially to go back to 18, 19, like really hot economy. We actually rely pretty heavily on machine learning to figure out where to put stuff in the warehouse, and that affects a increase in labor productivity. And so we basically the loss of the labor plus the good operational practices, some of which data science contributed to others of which were just learned and refined, um, by our operations team over years really kind of allowed us to net net them out. The the other thing that we did was intentionally simplified the orders. And so the objective of the supply chain under normal circumstances is to guarantee the availability of your cornea Copia of yogurts. You can stand in the grocery store and gawk at, I want boys and Berry gluten-free, whatever. Together we decided forgive my French, but ain't nobody got time for that s***. We started changing up in conjunction with our customers and said, okay, you used to ship five items out. Now you're shipping to, you used to want half this palette. Now you're getting the full palette and it worked out well because now they now have the demand

to use that up downstream. And so this was very, very, very much by design. But the critical thing is that, when you have a crisis, like COVID the work that you do before it matters the work that you do during it. And so take, take other failure modes that consumers may not know about. So take shrimp, shrimp is a very heavily imported commodity into the United States. Basically the Gulf is the only provider of shrimp in the U.S. and they're primarily distributed regionally. Most of the shrimp that we consume will come from Asia. And if you look at the rankings of the various exporters, the United States has been wildly gyrating for several years. So, Thailand went down, India went up, Ecuador -- this kind of upstart started at number seven and now they're number two. And this was actually due to an animal pandemic. Thailand, the primary supplier of shrimp to the U.S. market, was hit by something called the yellow head virus. It's a distant cousin of the coronavirus. And, um, so suddenly their exports to the U S are down 80%. We've had huge global warming induced squid shortages. Global warming is definitely a thing; it's something that we monitor very closely and it's just catastrophic effects on certain fisheries that we see in our data. And one of them was squid calamari. And so in 2013 you had 118,000 tons come in in 2019. We had 10% of that, less than 10% of that. And it was coming in during different times. And so these are things that happen when you are normally dependent on mother nature for all of your stuff and things that you're trying to hedge around. And so there's a, a working assumption in our industry that like, you're just going to get kicked in the head. El Nino is going to take out a bunch of fruit or some fishery is going to fail, or some pork viruses recently in China is going to take out 60% of the Chinese pork population. That's just normal for us relative to COVID.

So the net result of that is that we store a lot of inventories. And so there's just enormous quantities, like months of supply sitting upstream and certain freezer and refrigerator commodities. And that's really what we relied on the difficulty was not whether the food was available. It was schlepping it and the relatively high demands. And in retrospect, it was actually about the size of Thanksgiving. And so these warehouses will be referred to as our mega RDCs. They shipped directly to retail distribution centers. You see this upswing and kind of mid March to mid April, that's COVID, but you see these huge upswings during Thanksgiving and Christmas, and that's normal. No one thinks twice about it. But the difference is you don't know when it's coming. So we didn't know exactly when it would happen. We didn't know exactly how big it would be. We didn't know exactly how long it would last. And so then it becomes an exercise in trying to put out fires and some of the fires. Some of the fires were that we had made the decision that we needed to de-con certain facilities. And so how do you, like we're not going to compromise worker safety. And so, but now you have to start bringing in product from other warehouses. Now you started to have to play musical chairs as it were. Um, some of the failure modes were just that there was huge regional differences in panic buying. This facility serves the Northeastern U.S., so this is a 75% increase in their volume. And like, what do you do with that? In their particular case, we employed a whole bunch of strategies, simplifying orders. The ops team at that particular site is just absolutely tremendous, and they

had worked close with the customer on everything from how to simplify the orders to get the trucks to be on time so that they didn't have anyone standing around unutilized. O the flip side, this facility serves Los Angeles. The entirety of Los Angeles basically seemed to go, uh, Instacart, yo! And so then it becomes an issue of how do you, how do you play whack-a-mole as it were, and that's, uh, an operational question you absolutely positively need the highest level skilled operators. I mean, it is a, it is a skill, uh, to manage a plant and schedule your labor and motivate people to make stuff happen when it needs to happen. Um, but it's also a data question we have, uh, developed over years the systems in place to be able to see all this stuff in real time. Um, we can see automatic operational alerts of whether something's about to go sideways. Um, we have a whole bunch of techniques for that, but we also have a whole bunch of infrastructure for it.

JG: This is probably a good segue back to our topic of, of data science and AI. I mean, that was an incredible, you know, I don't, I think most of us were alarmed about food and then we're relieved that it didn't end up being a crisis, but I don't know how much of us realized that how much work was going on behind the scenes to keep it from being in crisis. But can you give us a sense of how data science and your team in particular were able to help with the firefighting?

EW: It was the guys in the warehouse. I mean, I got to give all the credit to the guys in the warehouse. I think, um, they went above and beyond. Um, and this was at a time when we didn't fully understand how to protect against COVID transmission. Um, and in retrospect, warehouses are very large. You've got about 2000 square feet per employee, but at the very beginning of this, no one had any idea of like someone sneezed in a freezer and then someone walked in the same vicinity a day later. What does, what does that do? Right. Um, and so, uh, the real heroes of this were at the site, uh, as far as data science, as far as data science is concerned, there were really a couple of things. There was first, um, it was first the systems that we helped build over years for monitoring the operational health of facilities. Iit's a pretty common IOT application. It's almost like the default IOT application is to predict machine failure, but large industrial plants, particularly ones that are manually operated are very much like machines. You've got this thing, feeding this thing, feeding this thing, this process, feeding the next process, feeding the next process. And it becomes cyclical. And if you have a problem in one particular location, that's going to break something downstream. Um, it's but there's a huge stochastic element to it, which is the person. And so, uh, it's more of a statistical exercise than anything else to figure out. Okay. How big of a deviation is something that we have to worry about? Because this thing is not going to be as well behaved as a diesel engine, but, uh, there, there are certain things that we can see. And so we relied very heavily on the experience from other operational issues we had had over years in the run up to COVID and the learnings from those and how you respond.

There's a specific operational playbook of like, okay, if I see this start to surge, then I take this action. It's indicative of this other failure mode. Um, and so we were relying very heavily on that. And we were kind of, uh, we were the ones kind of playing the video game, watching the charts everyday, like, okay, Jeff -- our chief operating officer's name is Jeff -- alright, Henderson is searching like they're having a problem in this area. Uh, so the team was all hands on deck doing that. Um, and then the other thing was we were doing, um, we were doing all of the data analysis supporting the simplification of the orders. Um, it's actually a very, very large, uh, deviation from normal third party logistics practice to say, I'm going to send you a quantity of stuff different than what you ordered, if Amazon does that either up or down and then charges you for it, you're upset about it.

So then this became this, this all hands on deck, a series of interactions with customers to get their approval for this. It became this very complex. I mean, we were like scripting the modular arithmetic for this, because the way you simplify orders is to have quantities that are exactly divisible by certain numbers, whether they're layers or full pallets. And so we're running these mods scripts that we wrote on like a Saturday against the orders that we're going to ship on Monday saying, okay, if we do this, this is what's going to happen. If we do that, we find that kind of sweet spot it's in negotiation.

JG: I went to the grocery store and they just take what they get. It may not be what they ordered, but they take what they get.

EW: Lastly, you have a whole bunch of a whole bunch of work streams to try to keep people safe. Lineage is a very large organization. We've got about 15,000 employees in the US and so you're now asking questions, like, where is COVID versus where are our people? Um, even if we don't have direct, uh, indications yet of coven infections, that particular facilities, where should we be worried about in the context of, uh, of who lives, where, um, and, uh, and then all of this, while the supply chain is contemplating the kind of new normal and the new normal for the supply chain is one that's less dependent on humans. So that's a robotics thesis. So we're designing the robots, um, the new, normally designing robots right now. Oh yeah. Oh yeah. The simulation we, I showed you was a production simulation. So we're the ones deciding: I want to build this robotic warehouse, what does it need to do? That's a statistical question then. Okay. I have this candidate layout. Is it capable of doing that? That's an extra exercise in scientific computing. Um, what is the future supply chain gonna look like? Because we get to build this building once and modifying it is going to be prohibitively expensive. So now you're going into this kind of stochastic exercise of like, well, what will the future look like and how future-proof am I that involves like doing a whole bunch of Monte Carlos, to try to break your stuff before you build it and figure out what's, uh, what it works against and what it does.

JG: This phrase is something that I've often wondered about in the context of covered, which is, you know, most machine learning models, you know, rely heavily on training data. And yet, um, you know, we're now in a scenario in which the future does not look like the past or the present does not look like all our historical data. And so pretty quickly you'd like your training. Get it. If you're trying to make predictions based on what happened in April of 2019, you're going to get it completely wrong for April of 2020, what do you do?

EW: First, to give you a short answer to your question, we don't know yet we have not decided here is exactly what we can rely on what we can't rely on. Um, but to show you, um, how the ML behaves during, uh, the COVID spike. We had a train then we kind of reached steady state; in this stuff, the model doesn't really reach steady state until the physical warehouse reflects the new model.

JG: So this is showing errors one more time. What does the error mean?

EW: The prediction that we're making is pallet of chicken nuggets arrives, uh, at warehouse ex, um, we're predicting how long it's going to stay to execute a thesis, uh, whereby we put the stuff that we need to access frequently at the front of the warehouse and it convenient location. And we put the stuff that's going to sit there for months or years, uh, in the back of the warehouse. And so we're predicting that 85%, right? So your error here is, um, the absolute value of the actual time spent in the warehouse minus the predicted time spent in the warehouse. And so you can see here, we were just humming along then. Um, we, uh, decided to close and decontaminate the facility. So you had kind of a pause and everything. And then the supply chain actually doubled down. Um, and this was partly us. We were sending predictable orders down the pipe in order to make sure and anticipate the needs of the retailers. And so the supply chain kind of doubles down the air actually goes down for a little while and then around mid April, something weird starts to happen. And, um, people are going to spend years analyzing all of this. And I don't think anyone has a, has a totally, uh, obvious answer to this, but our hypothesis is that kind of, you go through COVID for a few weeks. You're sheltered in place. You're ordering either your naive notion of what's going to be what you, what you need to survive, like peanut butter and jelly and, um, and pasta. And you're just like, go and go and go and go and gone. Um, and then you start to think, okay, this is gonna last a while. And so now you start to see emergent cultural phenomenon. Like I want to bake bread at home. Well, that requires a certain bill of materials that requires East. It requires eggs. All of that had all of that happened and suddenly eggs are short Easter short, and that's throwing off our expectations.

JG: That was a genuine change in demand. It wasn't just like a time shift, like shifting ahead, my purchase of pasta. It was like, I genuinely didn't bake terrible sourdough bread this time last year, but I am this year.

EW: Exactly, exactly. And so that didn't happen until later, like everything else was just what, you're, what we call it. The bullwhip it's called the logistics, the bullwhip effect where you just kind of pull stuff and then it pulls back on you. But the new emergent phenomenon are actually like cultural in nature. And so take, take this. Um, I saw this picture, I saw this in my local grocery store. I live in Oakland. I was at the Safeway in the North shore of Alameda. And, um, there's whole Thanksgiving turkeys sitting there in the, uh, in the meat section. This was during the time when people were, uh, when some of the, some of the, um, meat processors were shutting down and someone at either Safeway or Butterball turned around and said, Hey, there's a quasi protein shortage. Or there's a fear of protein shortage, and everyone is stuck at why the hell not? Well, now you have Thanksgiving, like conditions where you need to feed a lot of people. Um, you want protein, and, uh, I can tell you, this inventory is in existence. The inventory build for turkeys for Thanksgiving 2020 started the day after Thanksgiving, 2019.

JG: You heard it here first folks.

EW: Right. So you're seeing retailers kind of push stuff forward and tell themselves stories and try it. Um, it's not like there's a mechanism for a Safeway consumer to say, I want a Turkey. And then it's, it's not like Amazon where it's just like, you have the direct connection between the supplier and the retailer. This is someone, some logistics manager deciding, you know what, Thanksgiving turkeys might be something we should try. And then we check in our data. It turns out it's catching on...

JG: People bought turkeys.

EW: Right. And so the upshot here though on the trading data is that this error, even at its worst at 20 data, is since settled down to about 15, uh, which is not that far off from where it started. But, um, it was actually better than the old human predictions we used to use. Um, they used to be off by months. And so, uh, do you throw it out, even if you assume the bias, even if you do nothing to counteract the bias, you're still largely doing better than you once were. And these cultural phenomenon are relatively recent and new. And so it's an interesting thing to explore what I see us doing more as kind of selectively, selectively, trying to curate this of like, okay, testing, throw out the shortages, like literally throw out the data when there were certain pork and beef shortages, because that's, that's truly a unique, right. Um, but, uh, do people start cooking Thanksgiving turkeys in April? Well, depends on whether you're at home or not, which is in the current environment is a geographic question. Geographical question. What are the restrictions in each state?

JG: Switching gears a little bit, you know, one thing you mentioned is that you worked with a startup to develop a vision system for forklifts. You're someone who does buy from, from

earliest AI startups. Right. We have a bunch of entrepreneurs in the audience, as well as investors. What's some advice you have, um, that you would, if you could give a piece or two of advice to young AI startups trying to sell to logistics providers. Yeah. So what advice would you give?

EW: I think, especially in the product management realm, ton of funnel, people use the word empathy. Um, I don't know if I mean it exactly the same way, but, um, a lot of, a lot of startups who try to make sales pitches at us, they're terribly empathetic when it comes to like, to them, their startup is the center of the universe. And so they're interested in this one and only one particular application and very often and good for them. The startups application is, is hyper-focused, it could be computer vision for X. It could be this particular type of inventory management or this freight execution platform or whatever. But, um, imagine just in the context of what I mentioned about COVID and our problem set in general, if like we're fighting fires in all different directions. Um, and so it's usually not that successful to come at us directly with like, here's my product. Like you need to buy it, cause I think it's important to your business. It's like, well, that may be true, but, uh, I've got problems with six zeroes on them. I've got problems with seven zeroes on them. I've got problems with eight zeros on them. And sometimes I got problems with nine zeros on them. And so which one is it? Um, what I think, what I think is the best way to go is that, um, like if you are doing technology right in an industrial setting, talent acquisition has to be at the top of your priority list and talent acquisition can come from direct employees. I mean, I said, we have a 12 person team love them to death. They're absolutely fantastic at what we do. But 12 people is not enough to manage all of the mathematical engineering underlying about half of the refrigerated food supply.

So we have partners, those partners could be startups. Those partners could be graduate students. Those partners could be other industrial companies. And the ones that have been most successful are the ones who tried to understand our business. And, um, then we might have like a year or two long sales cycle where they understand our business, I understand their capabilities. And then suddenly like we got a nine digit problem and let me make your day. Like, but, but that discovery process is very much like recruiting and it's very much like what I was describing in the very early stages of data science, like learn the business.

JG: Yeah, it's truly a partner relationship, not a, not a vendor customer relationship. Fantastic. Well, we've been joined by a couple of folks from the audience who have, uh, who submitted a couple of questions for you, Elliott. And, uh, and so we're going to, we're going to invite them up now. Um, let's start with Mike Cantrell. Mike is, uh, a cofounder at parcel and, um, and Mike White, welcome to the welcome of by slide. Uh, please share your question for Elliott.

Mike Cantrell: Thanks for having me. So we work in supply chain with perishable goods. And then my question to you is, um, what risks there are to perishable goods at Lineage and how your team predicts them. Yeah, so there's, um, broadly three ways that perishable goods can have a problem. Um, the first is contamination, uh, and that usually happens before the goods would get to us. So it would be like a romaine lettuce with Ecolab that's packaged and, uh, you can't unring that bell once it goes through the supply chain. Um, the second is, uh, thermal control. And so, uh, when I showed one of the fluid dynamics simulations, that's, uh, probably the highest stakes thermal process that we undertake where you deliver or a food company will deliver hot product to us. It's ambient temperature, or it could be even at body temperature because it's recently slaughtered.

EW: That has to go from liquid to solid, uh, at the risk of oversimplifying things very, very quickly. And, um, so we have spent absolutely enormous amounts of both brain damage and resources, uh, figuring out how to do that much more consistently. Then the third implicates the word perishability itself, stuff takes just too long to get through the system and the primary, the you've got competing priorities when you're trying to move stuff you want landed as quickly as possible so that it has as much shelf life for the consumer remaining. You also want it landed as quickly as possible so that you can hold less inventory. The inventory terms are quite a big economic factor here. But on the flip side, there are other reasons to move it slowly through the supply chain. Most of the product that we handle is either received or sent via long haul semi-trucks and so 18 Wheeler, 40,000 pounds net weight of product. And if you need to almost like have lumpy enough shipments and wait long enough in order to fill one of those things up or else drive half empty that doubles your energy per ton mile. And so, um, we kind of, we feel like we've solved blast freezing. I mean, there's been so much innovation around blast freezing, and it's been, how do you bring in innovations from data centers and aerospace and the car industry in order to get good airflow profiles?

There's additional work to be done on packaging. Designing packaging is like designing an airplane in certain respects, but that speed it through the supply chain and have your cake and eat it to get both the truck utilization and the, the decreased time on target as we call it. Um, having those two things together, that is a really complex coordination problem of, okay, these two actors might not independently have enough volume to fill in a truck, but if I can recognize them, I can double them up and I can get them both. Neither one of them will have to wait because we can, but now you're taking all kinds of data. You're making all kinds of predictions about who's going to be sending what, um, you have carrier complexities that you have to, you need a whole bunch of software, uh, software built in running around this in order to actually execute the orders for freight. Um, that coordination problem is where we think most of the action is. And this has huge implications for food waste where, uh, generally speaking the waste through the supply chain is actually quite minimal. If you define it as is this good when the consumer bought it? The waste that happens is, oh, the strawberries only had four days of

shelf life in the consumer's refrigerator. And then the consumer didn't eat all the strawberries in four days. And so then they chucked them. Well, if you can get that through the supply chain a week faster, you go from four days to 11 days of shelf life, once it's in the hands of consumers.

JG: That's fascinating. I never thought about truck. I mean, I have thought about truck utilization as a logistics problem and an efficiency problem. I had not thought of it as a parish ability problem. That's really cool. Mike, thank you so much for joining us and asking that question. Um, now I'll invite Brennan Turner, from FarmLead to share his question.

Brennan Turner: Thanks for having me and coming into UI from Ottawa Canada this afternoon. My question is around food logistics. What do you think is the bigger issue or bigger challenges that's specifically related to the last mile delivery? Or is it more in the, the long haul, figuring out where, where supply should meet demand, i.e., California avocado is going to New York city or something like that, right?

EW: It all varies. We talked in Mike's question about the different trade off between perishability and truck truck utilization. Um, if you're looking at the last mile delivery, um, the nature of the distribution centers at the local level, the facilities that byte, uh, provide to an individual consumer is there so space constraints that there's no way they could make a play for good utilization. And, um, they're also, uh, the distances that they drive are so little that, uh, compared to driving across North America, that you're just, you're just admitting to yourself that you're gonna get really bad utilization and you might actually get such bad utilization that actually takes more gas to deliver it from the local DC to the consumer than it does to take it from, uh, Salinas, California, to New York City. If you just divide the, the fuel efficiencies of the different modes by the amount of stuff that you're storing, it's just immense. Um, it's gonna vary widely by channel. Um, even though e-commerce is a huge growth area for the food system, you are still gonna have Costco. You are still going to have a certain segment of the population going to the grocery store, uh, to buy things in that particular case. It's, uh, really in the long haul. And it's really in the truck logistics.

I think where this becomes interesting is, does e-commerce grow to such a level that you can actually get good utilization on the, um, on the last mile. And, uh, the growth is there to ultimately achieve that within a few years, but, uh, what's becoming difficult is that, um, is that a lot of the platforms are competing on the basis of things that make good outcomes difficult, so you can place an order and have it delivered within two hours. That's actually a really, really, really bad thing for transportation utilization, because if I could say, well, Hey, you tell me about your order a day ahead. And now we can go through and route optimize and send one picker to go pick 10 people's, 10 people's grocery store that trip from the grocery store to the local neighborhood is now 10 times more efficient. Vis-a-vis the gasoline use. Um, and so, um, there's a lot of complexity. It depends on the channel. And I think, I think we have to address

both, um, the most of the Amazon trucks are empty or not empty. They are own less than half utilized. Most of you imagine the efficiency of an Uber eats driver, you might be moving 20 pounds of food in a single vehicle will long haul truck will, will shift 2000 times that amount. Um, but on the flip side, um, shirking utilization, at least in the refrigerated space is only about 60, 65%. And so you see all those trucks driving on the highway, and they're only about 65% utilized on average. And so both of them are rather fruitful areas for, uh, investigation.

JG: Sounds like a massive opportunity on the table there, not just for sort of efficiency and cost savings, but also like thinking about all the, all the fuel consumption.

EW: Right. Yeah.

JG: Wonderful. Well, Brendan, thank you so much for joining us really appreciate it. Everybody in the audience has a Q and A panel at the bottom and you are welcome to submit. I have more questions for Elliott, but you guys are welcome to submit questions too, and I'll try to weave them in. Elliott, I have a question that looks like it's from one of my coworkers. They want to know, are there hedge funds trying to find your data?

EW: There have been, yeah. There have been some discussions, but at this moment, our data are things that we use to improve outcomes for the supply chain, period.

JG: Perfect, good answer. I wanted to turn to, um, a topic you touched on really lightly when we were talking about startups, um, which is that, um, that, that sort of, that it's all about talent. And it's interesting because when I talk to enterprise data science leaders, so many of them feel like that is their fundamental problem. It's not a lack of problems. It's not a lack of ideas. It's not a lack of resources. It is. How do I actually manage to recruit data scientists against the fangs? And you get your own reason for doing that, but what are your, can you share any recruiting secrets to whether with our audience?

EW: I have felt that the way that my current overlords came at me was frankly very effective. Like if I put myself in the shoes of a technically interested person, who's up for an adventure, um, the things that they did well in managing a process with me were namely agency and respect for the things that I knew that they didn't, but also my respect for the things that, um, they knew that I did. And so I thought, I thought the recruitment process was an adventure whereby, Hey, I get to see all this infrastructure. I've watched modern marvels in the history channel my entire life now go into these sites. Um, and so we try to do the same thing when we recruit people. Um, we generally recruit for differentiation as opposed to scaling, um, like to hire a lot of people who can do stuff that we can't. And in that particular...

JG: What's the background of people you end up hiring; are they are these new college grads, mostly?

EW: The plurality of them are physicists. Um, we've also got a marine biologist who, uh, helps us understand the fisheries dynamic. Um, we have a few engineers. Um, we have even an environmental fluid mechanics, PhD out of Stanford. Um, historically we have gone after people coming out of graduate school and, um, the maturity level is higher, but, um, we now feel we have the infrastructure that we're going after younger and younger people. And so, um, but when we go after like, like take the hardest thing to recruit in the supply chain, which is like a, a kind of experienced level data scientist, like that's probably the talent supply fan. Right, right, right. This is sorry, this is the talent supply chain, um, experienced data scientist in that particular case. You respect the fact that you're hiring them precisely because they know more than you do. When we do that, we actually don't start with a job description. We'd like to read them into our problems and then ask them what we're screwing up. And then through that process together, there's a self discovery on both sides. And, and also, uh, if it goes well, a kind of building of excitement for, uh, what the future holds people, the, the primary things that we offer are, um, I mean, comp is comp you have to be competitive, but, um, agency and story are the things we try to give that Google just could not give anybody like the right to decide what you work on, relatively little supervision, uh, the ability to take something totally from inception to, or to a production. Yeah.

JG: All those are, I think, really great tips. I've got a couple more questions filling in here on the chat. Yin Fang wants to know, what type of tech do you buy versus a develop in house?

EW: So we have a whole bunch of tools that we'll lean on and it's strongly depends on what we're doing. Um, for operational dashboards. Um, we've used, uh, kind of outsource software development shops. So we're really good at kind of front end and back end web development. They're building off of a pretty standard tools, angular, um, usually Postgres databases, um, kind of stuff that's available, um, for kind of emergency production stuff. Um, like some of the stuff that went down at her COVID, um, we were relying pretty heavily on Periscope, which is now Sisense. Um, a lot of the stuff that we do, uh, is actually not manifested in a web product. And so it's, uh, it's manifested in the physical building design. We push, we use data science to figure out what the rack opening sizes should be for a warehouse pallet rack. That's not something that needs to be debugged and beta tested, and it's just like, no, here, mr. Contractor, here's your design, like, go do it. Um, and that's something that we do once and hope to never touch again. And so in that case, it's much more like a graduate school experience where you're, um, writing an academic paper where the actual product is the, the visualization, whatever else. And so for that, we're, for that we're using a stack that looks would look very similar to any technical graduate student in the United States. Our MATLAB Python and does, um, we use a lot of discrete event simulation. We, I try to stay as open

source as possible, and that's both philosophical. That's both philosophical, but it’s also just absolutely amazing what's available in terms of Python libraries in terms of our packages.

JG: Completely. We've got another question here from Chris, how robust is the required sensor data in a cold chain? Are there Achilles heels in monitoring and data collection, and how often do you need extra hardware?

EW: So, there are federally mandated minimums when it comes to monitoring. I assume when you talk about monitoring, you're talking about temperature monitoring. Um, although in trucks, maybe also shops, yeah, there's also vibration monitoring needed for certain sensitive commodities. The feds like vibration as a failure mode will not make someone sick temperature as a failure mode will make someone sick. And for things that will make someone sick, the FDA has a set of rules that you just have to follow. There's pretty common practices in trucks where you put in something called a temp tail, which is the sensor about the size of the deck of cards. And it changes color if ever the, the temperature exceeded a certain set thresholds. So that's broadly sufficient to make sure that someone doesn't die.

EW: If you hear a food safety issues, they're almost always due to contamination at the source. So it'd be like Ecolab outbreak or listeria or something that had to be in there that doesn't just, and even if, uh, most of our inventory that we're moving is freezer. Even if you thought that it's still not a particularly good environment for bacteria to grow, it's just, you went from ice cube to chilled stuff. Consumers can imagine that, um, now that has not been enough for us for a lot of our applications. So, um, one of our primary applications is actually load balancing the power grid whereby we have tremendous thermal mass inside of these facilities. So we will actually schedule their power consumption to avoid peak energy rates. And the effect of this is though sometimes they're consuming more than they otherwise would. Other times they're consuming less. So you put a behind the meter battery system on your cold storage warehouse. Now, if you're going to do something like that, you're actually intentionally thermally cycling the food supply. Um, we added two zeros on the sensor counts so that we knew exactly what was going on in that, in that area. And not because we were concerned about losing control in a particular area, not that we were concerned about thawing something accidentally, but because if you're going to do that, you need to have a very precise thermal understanding of what's going on in your warehouse and the way to judge, whether you, what you think is going to happen is actually going to happen is how, how close are your models to your sensor data? And so suddenly we start deploying lots and lots and lots and lots of sensors, um, so that you can make 3D temperature maps of this warehouse.

JG: That's so cool. I think we have time for one last question. Um, I'm going to pressure you to answer it quickly, but I think you may have a terse answer. Monica asks, how do you prioritize projects when you're not dealing with a pandemic? Do you always have clarity on the dollars

available in coming up with a solution or is it more of like matching what people are capable of?

EW: This is how we prioritize is mostly a function of, um, the fact that we're private equity backed. And also, um, I have, I had experienced before I went to grad school working in private equity. We view it like investments. So the job of Lineage Logistics, which is privately held is to deploy capital, to turn it into more capital, like not unlike a venture fund or any other private equity fund. And so, um, take warehouse rack design. We throw a quarter of a million dollars at rejiggering the rack heights and it makes us $10 million worth of warehouse. So on a valuation basis, we've turned $250,000 into $10 million, which is a trade that anyone at any fund would make all day long. And, um, so that's how we view it is in terms of that arbitrage.

JG: You've mentioned something called the money equation to me before you wanted to just quickly share that.

EW: The economics of warehousing are really not that hard to figure out. You've got your revenue, which is a function of how much you can store, the quantity, times the price, which is usually a function of how commoditized your business offerings are. And then you've got two big expenses, power, and labor. And so all of the data science applications implicate one or more of those terms in the money equation with the sole exception. And I do mean sole exception of safety, whether it's safety of our workers or safety of the food consuming public. So each will we'll think through our projects in terms of the money equation and in terms of their costs. And then we'll say, okay, the most bang for the investment dollar is doing this or doing that. And in the seven year history of Lineage data science, we basically hit every single term of the money equation. Some of the projects have more than one. But that's how we think through it as if we were private equity investors.

JG: That's outstanding. Elliott, thank you so much. This has been fascinating. I've learned a ton today. I think our audience asks great questions. Thank all of you for joining us.

EW: Thank you. Thank you for all your support. You've been such a wonderful partner over so many years.

JG: A special thanks also to Brennan and Mike who joined us live. And if you enjoyed this, I hope you'll all mark your calendars for September 16th. Our next Zetta Bytes Live will be with Anthony Goldbloom, the CEO of Kaggle. And if you want to stay, stay abreast of future events hosted by Zetta then please subscribe to our newsletter. You can find it at zettavp.com. Elliott, thank you so much once again. Thank you everybody. Happy Wednesday.

EW: Cheers.