So welcome everyone, it is my great pleasure to introduce our seminar speaker today, Doctor Elizabeth Tipton. She’s an associate professor and faculty fellow in the Institute for Policy Research at Northwestern University. Unducted sentence research focuses on the design and analysis of randomized experiments with a focus on issues for external validity and generalizability.
as well as meta analysis with the focus on dependent effect sizes. Um, today she’s going to share with us how to design randomized experiments to better understand treatment effects. Head virginity welcome best. The floor is yours. Thank you. Thank you. I’m very excited to be here today. I really wish I hear I wasn’t talking about my office slash closet and was actually with you guys in person and this is my first time doing slides where I’m on the slide so it’s a little.
I don’t know what is the protocol for questions. How do you guys? How do you usually set this up? Do people what’s the norm? Do you guys usually up jump in with questions or save them for the end? So I think as you prefer, we can do either way. OK, I’m just I won’t be very good at checking the chat, so if there’s a question if somebody can just speak up that would be will do that. I’ll do that on the chat. OK, thank you. So I just want to set out background for what I’m talking about today, which is I’m talking about randomized
trials an I realized that in a Biostatistics Department, you guys. The idea that randomized trials are common is probably almost absurdly basic for the world that you operate in, but I do a lot of my statistical work in the areas of education and psychology and kind of in the field experiments world and those areas. Randomized trials have only become common really, I’d say the last 20 years. So almost 20 years ago, the Institute for Education Sciences was founded in the Department of
Education in the US government, and that has funded almost 500 what are called efficacy and effectiveness trials and education. Previous to that there were very few of these. There’s also an increasing number of nudge experiments in social psychology. I know that there’s a lot of rain in mice trials occurring in developing countries, so this is late in parallel, maybe 2. In public health, they’re being randomized trials there, so I’m just sort of pointing out
that these are becoming increasingly common for policy decisions, not just individual decisions. But the trials as there as they are designed currently are not necessarily ideal in the sense that they are not as big as we would like them to be. In order to be able to really explore the data well, there often in, you know, sort of somewhat small samples of clusters in the in the kind of education world that I work in it. They’re very often just simple to arm designs 5050 treatment control.
I much less common to see things like step wedge or smart designs, so those are trickling in, I think. The goal of these is often to get into some things like clearing House of some places so that policy making decision makers can use the information from the trials to make decisions. But the problem which is the focus of my talk is that there very often been taking place in samples that are purely of convenience, which makes thinking about generalizability and heterogeneity rather difficult. If the treatment of X very if treatment
effects vary across individuals or they vary across clusters in some way, then it's pretty straightforward to see as a group of statisticians here that the average treatment effect you would get in the population. Is probably not exactly the same thing as the average treatment effect in the sample, and that these could be quite different if treatment effects vary a lot aniff depending upon how the sample is selected. So there has been an increasing amount of work in this area. There's a couple of papers I think that are particularly helpful if there's
a paper in education where they’re looking at bias from non random treats. Non random treatment assignment or they show that the bias of external validity is on the same order as internal validity bias and so to do so they hear they sort of leverage and natural experiment with a randomized trial to look at this. And that’s worked by Bell, Olson, Oregon, Stewart. There’s also work showing that. In education and the kinds of schools and school districts that take part in randomized trials are different than the populations of various populations.
At something like the Institute of Education Sciences might be interested in, so I have a paper out with Jessica Spy, Brooke Ann are students looking at 37 randomized trials and the samples of schools taking part in those studies and comparing them to various populations of schools. In the US. There's also work hidden behind me. By Liz Stewart. San colleagues looking at school districts and a couple of other papers as well, and these find fairly consistent things. For example,
that large school districts are overrepresented in research. Relative to the size of districts in the US. There's been also a lot of work in this area of generalizability and post hoc corrections. I started into this work looking at using post stratification as a way of estimating a population average treatment effect from a sample. There's also been work using inverse probability weighting, maximum entropy weighting bounding approaches. There have been some approaches that focus on little,
so I’m thinking like.

Here’s the paper and Stuart San Green.

I think that does that,

so there’s been like a kind of

a flurry of method development.

I think here in this area of

thinking you know,

how do I actually estimate this?

If I have population data of different forms

and I have sample data of different forms,

how can I actually estimate a

population average treatment effect?

But when I first started doing this work,

I realized in a series of examples

that I was working on that the
effectiveness of these methods is often severely limited in practice because of undercoverage and what I mean is that it you can’t. If it turns out that your population has there’s a part of the population that’s just not represented in the trial, there’s really not much statistical magic you can do. You can make some assumptions, but you can’t really re wait something that doesn’t exist, and the. It’s it’s really a reflection of lack of positive ITI in the study. Yes, exactly thanks. Yeah exactly. And yeah, I’m just using survey
NOTE Confidence: 0.8677029
00:07:21.338 --> 00:07:23.180 sampling language for the same thing.
NOTE Confidence: 0.8677029
00:07:23.180 --> 00:07:24.720 That’s right, yeah, and so.
NOTE Confidence: 0.8677029
00:07:24.720 --> 00:07:26.869 And that’s the lack of positive ITI
NOTE Confidence: 0.8677029
00:07:26.869 --> 00:07:28.535 often arises because people aren’t
NOTE Confidence: 0.8677029
00:07:28.535 --> 00:07:30.605 thinking about what the population is
NOTE Confidence: 0.8677029
00:07:30.605 --> 00:07:32.638 in advanced and so it’s very tricky
NOTE Confidence: 0.8677029
00:07:32.638 --> 00:07:34.550 for them after the fact to generalize,
NOTE Confidence: 0.8677029
00:07:34.550 --> 00:07:36.410 because it turns out that maybe
NOTE Confidence: 0.8677029
00:07:36.410 --> 00:07:38.249 this what I as analyst him now
NOTE Confidence: 0.8677029
00:07:38.249 --> 00:07:40.284 trying to think of as the population
NOTE Confidence: 0.8677029
00:07:40.284 --> 00:07:41.908 isn’t exactly the population,
NOTE Confidence: 0.8677029
00:07:41.910 --> 00:07:43.905 but it’s very hard for people to
NOTE Confidence: 0.8677029
00:07:43.905 --> 00:07:45.589 articulate what the population is,
NOTE Confidence: 0.8677029
00:07:45.590 --> 00:07:48.810 and so spent a lot of time just trying to.
NOTE Confidence: 0.8677029
00:07:48.810 --> 00:07:50.826 You’re out what the population actually is,
NOTE Confidence: 0.8677029

14
and if that's population is meaningful, 

So I realized I pivoted a bit.

I realized that you could do a lot of this with statistics,

but you were going to be limited if you didn’t design better trials.

And so that’s allowed me to think.

Well, why don’t we just start?

The beginning and do this do a better job this so why?

What have we started at the beginning of our studies by asking what the target population of the intervention was thinking about inclusion and exclusion criteria,
I think it helped.

This probably matters even more with comorbidities and you know.

I like rolling out people.

You’re doing a study on depression, but you rule out people with anxiety, and that’s like a big problem for the interpretation since they were highly related to each other. This is true in education as well.

So like, what are the inclusion exclusion criteria for your trial and how might that affect where you can generalize? And then also thinking about...
background characteristics and contextual variables that might moderate the intervention’s effect and the tricky part here is, there’s a little bit of a circularity which I’m going to keep coming back to in what I’m talking about, which is in order to know these, you know, we don’t know what these are in advance, and we don’t have a lot of knowledge generated to date about what these variables are, because studies have not been designed to estimate or test hypothesis about moderation, and so instead we have to sort of think
through what we think might matter.

Using, you know, not a great source of knowledge here, but the idea is that you sort of take all of this information and use sampling methods to actually design recruitment procedures like using stratified sampling. Figuring out if you should Figuring out if you should within Strata, using balanced sampling or random sampling and thinking about sort of ways in which you can increase the
coverage so you can have positive

NOTE Confidence: 0.881084

ITI for the whole target population,

NOTE Confidence: 0.881084

so that when you do know.

NOTE Confidence: 0.881084

When you do need to make adjustments

NOTE Confidence: 0.881084

at the end of your trial using

NOTE Confidence: 0.881084

these statistical methods,

NOTE Confidence: 0.881084

they are in a realm in which

NOTE Confidence: 0.881084

they can perform well.

NOTE Confidence: 0.8562651

This this sort of lad me to thinking about

NOTE Confidence: 0.8562651

tools for general for generalization,

NOTE Confidence: 0.8562651

and so I just want to highlight this

NOTE Confidence: 0.8562651

because I think this is a good strategy

NOTE Confidence: 0.8562651

for methods people to think about.

NOTE Confidence: 0.8562651

So I I thought will nobody is going to do

NOTE Confidence: 0.8562651

what I’m telling them to do if I don’t

NOTE Confidence: 0.8562651

build a tool because the kind of people.
Clan randomized trials, at least in my domain, don’t often have statisticians ready at the ready to work with them on things, and they are often writing grant proposals before they’ve got funding, and so it’s very possible that they’re not going to think about generalization or or have the training or tools to do it so. I got a grant from the Spencer Foundation and then I’ve had follow up money from the Institute of Education Sciences to build this tool called the Generalize are that uses some basic design principles standalone.
It's got.

It's very focused on the user experience and it in the background has the Common Core of data which is. An annual census of the public schools in the US so that the data is already been cleaned and set up. We're adding in right now the iPads data, which is higher Ed data in the US and so the idea is somebody could go in and walk through inclusion exclusion criteria identified moderate orsan. It would build you stratified recruitment plan in less than an hour. You could leave with a list of all the schools and start being able
to recruit with the.

Great, I've had this going since 2015 and it was very slow going for awhile. This is sort of. I just realized this year that I could actually extract a lot of user data and So what you can see here is actually it was slow going and I had some early adopters.

These are people that would be star users, so many of them are planning randomized trials, but there was actually a very big jump that occur this summer and that’s based on this jump. I actually started digging through
things and realized that.

Institute of Education Sciences that actually enacted requirements for generalizability. In their request for proposals, and so you can see that what I already always speculated, which is that funders really drive change. So once funders said you need to pay attention to generalizability, people actually started paying attention to generalizability in their proposals. OK, so this I just wanted to give you all of this background as a way of explaining sort of my like where I’m coming from in the in heterogeneity and how I’m
thinking about this.

So everything I’ve talked about is sort of averaging over hedge and 80 when we talk about analyze. Estimate an average treatment effect for a population, assuming that there’s variation of effects and we’re averaging over those. But to average over those requires that we know something about how treatment affects very and very often, and I would say this is the in general we don’t, and the reason that we don’t have a
great handle on this is because sample
size and sample sizes in randomized trials.
I've been very focused on the after treatment effect.
Moderators have only become more of a focus, at least in education.
More recently, and they are often more like exploratory analysis at the end, so you end up with these problems where moderator effects don’t get replicated and they don’t get replicated because there was.
You know,
who knows how many statistical tests conducted in order to find those moderators. So they’re not very stable, and we don’t really necessarily understand or their underpowered deeply underpowered like you just have a very homogeneous sample. And so how are you going to find a treatment effect variation if there’s not much variation in your sample to start with, so they’re often an afterthought, but I what I noticed overtime is that as generalizability has become something people are paying attention to,
people are also starting to pay attention to the idea that you could predict treatment effects, or that you could identify subgroup effects and that this might be very useful information. Which led me to start thinking about how you would design trials for this. So what I’m going to, what I’m leading up to is talking about designing trials to think about heterogeneity. So I’m just going to start with like a little bit of a background here. So we’re going to assume that you’ve got.
I'm assuming we've got units which are usually here. Let's say students insights which might be schools, and I'm doing a randomized trial, and I've got these potential outcomes. And so we've got both an average and intercept in these, and we've also got some sort of fixed variation that we can explain. And then we have this other parts that are not affected by the treatment. We've got some site level and individual residuals and some idiosyncratic errors. But what we're interested in
really is in these these moderate yrs of treatment effects,

and so you could say that Delta 0 is the difference in averages. I’m assuming these are centered variables, so this is nicely the difference in averages and that the vector Delta is the difference between these effects of the treatment and then under treatment and under control. A lot of so as you have to think about interpretability here of what I mean by Delta. By this by these deltas and how to standardize because we wanted to talk about these,
they need to have a mean of 0, but also in order to talk about treatment effects. Sort of done in general for developing things like power, we often standardize them so we often have effect sizes for the average treatment effect, their standardized in relation to the variation in the sample and the population. And so here I’m going to sort of say we what we need to do is we need to standardize the covariates and we need to standardize the.
covariates in relation to the population standard deviation. This might not seem like this is like a radical statement, but if you look into the power analysis literature on how to conduct power analysis for moderate are tests, they are typically standardizing in relation to the sample standard deviation, and in doing so, it makes it impossible to see how your sample actually how you choose your sample might matter. Isibaya standardizing by this fixed value by the population, you’ve identified a population,
and now we're standardizing by that population standard deviation. That will make the role that the sample plays here much more clear. OK, so the fact that we randomized to treatment and control allows us to estimate these dealt these because I'm trying to encapsulate cluster randomized randomized block individual randomizer, all like versions of this.
OK, so I can do so, I can separate.

These are at additive or rather subtractive.

I guess the treatment and the control their step.

You can separate them.

And and through this I can think about statistical power, and for each of these moderator effects.

And so, one way you can do that is through the minimum detectable effect size difference.

I don’t know how common this is used in the sort of Biostats world, but it’s a pretty common metric that’s used in cluster randomized trials in.
The world I work in, and so it’s nice because it’s sort of easily interpretable, so this is the smallest affect size that you could for a given Alpha level which is affecting this. That’s like the critical value. This is sort of the smallest true effect that you could detect with the power that you with like 80% power for example. And so this is like a general form for this, and so what I’m showing is that its function, can I like move my hands?
I don’t know.

I’m just going to involve a lot of never mind,

so it’s a function of the variation in the population in that covariate.

It’s also a function of $S$, which you could think of as the sort of covariance matrix of the $X$ in the sample,

so those are different.

And then it’s a function of $N$, which is the sample size per cluster.

I’m assuming it’s constant here.

$J$ is the number of clusters and $P$ is the proportion in treatment. So

what is $\Sigma_{XK}^2$? Is?
The population SD of effect modifier or the population variance effect modifier? Is the population variance of the effect moderate or modifier? But then your square rooting it so it’s going to be gradual scale. OK, so just to give you a couple of special cases where you can sort of parse out some things. So there’s been previous work. I meant to include a citation here by Jessica Spy, Brooke and colleagues. That’s looking at power for moderate are tests. And so here’s 2 cases we have.
Site lab, site level, moderate yrs and individual level moderate yrs and.

I'm taking basically what they've got, but re tweaking part of it.

Because I'm factoring out this Sigma squared and noting that you can actually pull out this thing called RXK at the front and the RXK is this ratio of the standard deviation of the covariate in the sample compared to the standard deviation of the covariate in the population.

And So what you can see here is by doing that you by rewriting it.

This way you can see that our XK is
NOTE Confidence: 0.851218459999999
00:19:45.426 --> 00:19:48.293 having just as much of an effect on
NOTE Confidence: 0.851218459999999
00:19:48.293 --> 00:19:50.433 statistical power as things like the
NOTE Confidence: 0.851218459999999
00:19:50.433 --> 00:19:53.682 square root of N or the square root of P.
NOTE Confidence: 0.851218459999999
00:19:53.682 --> 00:19:55.506 These other parameters that most power
NOTE Confidence: 0.851218459999999
00:19:55.506 --> 00:19:57.178 analysis has spent has focused on,
NOTE Confidence: 0.851218459999999
00:19:57.180 --> 00:19:58.008 and that’s true.
NOTE Confidence: 0.851218459999999
00:19:58.008 --> 00:20:00.260 You know, in any of these designs.
NOTE Confidence: 0.851218459999999
00:20:00.260 --> 00:20:02.836 Love seeing it in any of these designs.
NOTE Confidence: 0.851218459999999
00:20:02.840 --> 00:20:06.114 RX shows up. OK,
NOTE Confidence: 0.851218459999999
00:20:06.114 --> 00:20:10.020 so if RX is something that matters for power,
NOTE Confidence: 0.851218459999999
00:20:10.020 --> 00:20:12.190 a question will be well.
NOTE Confidence: 0.851218459999999
00:20:12.190 --> 00:20:14.360 What are people doing in
NOTE Confidence: 0.851218459999999
00:20:14.360 --> 00:20:16.096 practice right now right?
NOTE Confidence: 0.851218459999999
00:20:16.100 --> 00:20:18.698 So maybe maybe people are choosing
NOTE Confidence: 0.851218459999999
00:20:18.698 --> 00:20:19.997 fairly heterogeneous samples,
and So what I’ve got here is 19.

This is 19 randomized trials in education that we extracted information from and we’ve got. So these are box plots of values across each of these 19, holding like the US population of school. So this is like the US population moderate are in the sample in these studies to the ratio of that to that standard deviation in the population OK, and then I’m looking at boxplots of this and what you can see like do this,
00:21:00.400 --> 00:21:00.737 don’t?

00:21:00.737 --> 00:21:03.433 OK, what you can see here is that

00:21:03.433 --> 00:21:05.230 the bar at the bottom.

00:21:05.230 --> 00:21:08.020 Can you see my cursor?

00:21:08.020 --> 00:21:10.369 Can’t tell if you guys can see my curse.

00:21:10.370 --> 00:21:10.631 No,

00:21:10.631 --> 00:21:11.936 you can’t see my cursor.

00:21:11.940 --> 00:21:12.182 OK,

00:21:12.182 --> 00:21:14.360 so the bar at the bottom there’s an R

00:21:14.425 --> 00:21:16.711 X = sqrt 1/2 and then there’s a line

00:21:16.711 --> 00:21:18.974 across the top that’s like a dashed one.

00:21:18.980 --> 00:21:21.570 That’s the R X = sqrt 2.

00:21:21.570 --> 00:21:21.885 OK,

00:21:21.885 --> 00:21:24.090 and so you can see that most

00:21:24.090 --> 00:21:26.298 studies are actually below there,
less heterogeneous than the population there.

Below this line for one, and they’re actually far less heterogeneous than the population there are. Actually.

If you look at these median values, many of them are closed 2.5, so they are about 1/4 of the variation as we’re seeing in the population.

So this gives you a sense that if.

That there’s, uh, an opportunity to improve, right?

Like I could increase power not just by increasing my sample size or increasing.

My sample size in schools or the number of
schools which are pretty expensive,

but I could also increase my power by changing the kinds of samples that I select.

And so that’s where these numbers came from.

They should have gone to slightly different order.

So the main point is that design sensitivity, the way we think,

whether that statistical power or standard errors or whatever framework

that there this is proportional in some way to this RX value that we can improve our design sensitivity by choosing a more heterogeneous sample.

And so funny, I must have like put
this in here twice on accident.

So this is the same thing but with a line through it.

OK so if once you have that insight that heterogeneity matters, we can include in our power analysis and that is something that is not actually happening in practice. Then we can start thinking about how we might plan studies differently. OK, so if. So how can we improve statistical power? Well, a lot of the literature as I was saying, is focused on improving power by
increasing sample size or instead. But what I'm arguing here is that you could increase instead this ratio. You could increase the variation in your sample choosing more heterogeneous sample annual have more statistical power for test of heterogeneity of moderators, and So what would you do with this? It would mean you know purposefully choosing sites that were more extreme, it might end, and that's easy enough to do in one variable. And I'm going to talk a little bit about how to do that with multiple variables.
00:23:31.140 --> 00:23:32.216 So with a simple,
NOTE Confidence: 0.8691194
00:23:32.216 --> 00:23:35.029 let’s just say we had one single continuous.
NOTE Confidence: 0.8691194
00:23:35.030 --> 00:23:37.298 Moderate are like this is a normal
NOTE Confidence: 0.8691194
00:23:37.298 --> 00:23:38.270 distance normally distributed.
NOTE Confidence: 0.8691194
00:23:38.270 --> 00:23:40.552 This theory would tell us that we
NOTE Confidence: 0.8691194
00:23:40.552 --> 00:23:42.479 should choose half of our sample.
NOTE Confidence: 0.8691194
00:23:42.480 --> 00:23:44.615 We would choose half of our sample
NOTE Confidence: 0.8691194
00:23:44.615 --> 00:23:46.891 from the upper from the upper an
NOTE Confidence: 0.8691194
00:23:46.898 --> 00:23:50.878 lower tails and choosing them from
NOTE Confidence: 0.8691194
00:23:50.878 --> 00:23:53.172 the upper and lower tails were
NOTE Confidence: 0.8691194
00:23:53.172 --> 00:23:55.172 actually getting an RX of sqrt 2.
NOTE Confidence: 0.8691194
00:23:55.172 --> 00:23:57.272 This is actually a rather large,
NOTE Confidence: 0.8691194
00:23:57.272 --> 00:23:59.000 so this is going to create a much
NOTE Confidence: 0.8691194
00:23:59.000 --> 00:24:00.810 more homogeneous heterogeneous sample,
NOTE Confidence: 0.8691194
00:24:00.810 --> 00:24:02.870 thus increasing our statistical power
NOTE Confidence: 0.8691194
00:24:02.870 --> 00:24:04.755 because it’s more heterogeneous than the.
In the population.

Similarly, if we had two correlated normal variables,

when we this is, you know,

we could imagine getting the corners of this.

These are all principles, by the way,

straight up from experimental design.

If you think if you think about it,

there are principles from like 2.

You know two factor studies or

multi factor studies where you’re manipulating and instead I’m just saying

instead of manipulating these factors

were now measuring these factors.

Someplace you could choose them
00:24:33.980 --> 00:24:35.550 to be extreme design points.
NOTE Confidence: 0.8697402
00:24:35.550 --> 00:24:37.434 It gets a little harder once
NOTE Confidence: 0.8697402
00:24:37.434 --> 00:24:38.376 things become correlated,
NOTE Confidence: 0.8697402
00:24:38.380 --> 00:24:39.950 so when they become correlated,
NOTE Confidence: 0.8697402
00:24:39.950 --> 00:24:41.868 I don’t have as much sample available
NOTE Confidence: 0.8697402
00:24:41.868 --> 00:24:43.816 to me because there’s just fewer
NOTE Confidence: 0.8697402
00:24:43.816 --> 00:24:45.596 population units in those corners,
NOTE Confidence: 0.8697402
00:24:45.600 --> 00:24:47.340 and so it’s going to become
NOTE Confidence: 0.8697402
00:24:47.340 --> 00:24:49.370 increasingly hard as I add variables,
NOTE Confidence: 0.8697402
00:24:49.370 --> 00:24:51.589 it might become harder and harder in
NOTE Confidence: 0.8697402
00:24:51.589 --> 00:24:55.960 order to figure out what these units
NOTE Confidence: 0.8697402
00:24:55.960 --> 00:25:01.780 are that I could be sampling from.
NOTE Confidence: 0.88043493
00:25:01.780 --> 00:25:03.660 So I started thinking about
NOTE Confidence: 0.88043493
00:25:03.660 --> 00:25:05.540 how you would do this,
NOTE Confidence: 0.88043493
00:25:05.540 --> 00:25:07.899 and I realized that there is actually
NOTE Confidence: 0.88043493
00:25:07.899 --> 00:25:10.690 a literature on this in in the world
00:25:10.690 --> 00:25:12.405 of sort of industrial experiments
00:25:12.473 --> 00:25:14.189 and industrial experiments,
00:25:14.190 --> 00:25:16.350 and in psychology people again are
00:25:16.350 --> 00:25:18.320 thinking about multi factor studies.
00:25:18.320 --> 00:25:21.386 So they’re thinking about things you could
00:25:21.386 --> 00:25:24.510 better in the experimenters control.
00:25:24.510 --> 00:25:27.009 But we could instead bout sampling in
00:25:27.009 --> 00:25:29.829 the same as the same kind of thing.
00:25:29.830 --> 00:25:31.720 Except that we don’t have control
00:25:31.720 --> 00:25:34.958 over manipulating them.
00:25:34.958 --> 00:25:36.130 an alternative approach,
00:25:36.130 --> 00:25:38.098 so one of the things we want to
00:25:38.098 --> 00:25:40.450 do is we want to make sure that
00:25:40.450 --> 00:25:42.549 we observe the full range of
covariate values in the population, so it requires us to actually think, you know, explore the population data and make sure that we can understand what that range of values is. We might need to think carefully about moderators that are highly correlated. It can be very hard to D alias these effects, so if you have two highly correlated moderators. I think about that. I have two highly correlated moderators like this. If I want to estimate and understand moderators of X, if I want to explore X&Z and
these are highly correlated, I’m going to really need to make sure I have those off diagonals that are kind of more rare in order to help me separate these effects and understand the unique contribution of each. The other is that if we might have many potential moderators that we’re interested in, we might need to make here. But also think very carefully, like we’re not going to be able to expand
this study to have a much bigger sample.

So a lot of what I'm trying to operate under the constraint here is, let's not change the sample size if we don't change the sample size, but we instead change the height types of units in our study, how much better can we do?

This leads to a principle found in response surface models called D optimality and so AD optimal design. This is work from the 40s and 60 Forties, 50s and 60s. A lot of work here by Walt Kiefer, and a lot of people in
industrial experiments.
The idea is that you can instead focus on the generalized variance an you want to minimize the generalized variance, which is the determinant. So D is for determinant.
And so the design that meets this criteria is one that also conveniently minimizes the maximum variance of any predicted outcome based upon these covariates. So this is great if what you’re headed for is trying to make predict individual treatment effects or site specific treatment effects.
The nice thing about a method that's been around for a while is that there's been algorithms developed for doing this. Better out Federov win algorithm is widely used and variations of it and that these are package that there are like statistics package. So designs that we know are optimal in other contexts. You know like our designs like Latin squares, etc all become special cases of this.
So this is a much more general framework that doesn’t require as many assumptions. OK, so once you start down this path you realize too that there are some tradeoffs here, so we have. You can easily imagine that the design that is optimal for an average treatment effect, which might be a representative sample. That sort of like a miniature of the population on covariates is likely not optimal for some of these standardized effect size differences where we might need to oversample in order to estimate, and so there’s another.
Benefit of this approach, which is that you can focus on augmentation approach and what that means is you can actually say using these algorithms better billable sites or already for I’ve already got design run so the language of this is these sites become designed runs. And I need to select 10 more. Meaning population units, what? 10 units can I augment it with that will improve that will make this as D optimal as possible given these constraints, and so instead so we’re thinking of population units as possible design runs and sample as design
00:29:33.769 --> 00:29:36.448 runs that we’ve chosen to use.

00:29:36.450 --> 00:29:39.762 OK, so I’m just going to go through

00:29:39.762 --> 00:29:42.388 an example to talk about this.

00:29:45.440 --> 00:29:47.456 Don’t have a ton more slides

00:29:47.456 --> 00:29:49.490 I should say so success.

00:29:49.490 --> 00:29:51.330 OK, so here’s an example.

00:29:51.330 --> 00:29:53.466 The success for all evaluation was

00:29:53.466 --> 00:29:55.332 an elementary school reading program


00:29:57.220 --> 00:30:00.388 The reason I like to use this example.

00:30:00.390 --> 00:30:02.476 Is that it’s old enough that strangely,

00:30:02.480 --> 00:30:04.388 they actually published in their

00:30:04.390 --> 00:30:06.560 paper a list of schools they

00:30:06.560 --> 00:30:07.624 actually named the schools in their

00:30:07.624 --> 00:30:09.059 study and characteristics of them.
I have other data on other studies where people have shared with me the names of the schools involved, but it's all like I have to keep it secret for the for IR be reason, so that the fact that this is available makes it easier to use. So what I did is I went back and looked at the Common Core of data I identified based upon the study that they were. In the way that they talked about their study, that Title One elementary schools in the US at that time might be a reasonable population to think that
they were trying to sample for.

Title one schools have at least 40% students on free or reduced lunch and meet a few other characteristics and then they identified in the paper 5 variables that they thought were possible. Moderators that would be really important to include here, so they talked about total school enrollment being a factor, racial and ethnic composition of the students. So I’m using that here as the proportion of students that are black and the proportion that are Hispanic.
and SES meaning and a professor but proportion at free and reduced lunch. And they also talk about Urbanicity because they tried to make sure they had some urban schools in rural schools and some other schools. So I should say in previous work of mine I've used this as an example and this study actually ends up being a fairly representative sample of the population, which is interesting. Is it because they had no real way of they weren’t doing it totally in a way that allowed them to compare this or to choose this in a way,
but they did a lot of work to try to be representative, and this is much more representative sample then.

So what I did for this example was I’m comparing for you the actual sample that they selected, so it’s always these five moderators. The actual sample selected a representative sample selected. If I instead I use something like stratified random sampling, The optimal sample based upon these
five covariates using this ALG design package and then various augmentation allocations.

And So what I would do here as I’d say. So if I used 36 sites that were selected with random sampling with stratified random sampling and then I reserved five of them that were selected using D optimality and then I would change, you know, the number of those. So you could see this sort of effect. You know that augmentation would have and then for each of these I calculated a few different statistics.
So you can see how this works. So one of them is D. This measure of the optimality. And I’m going to show you relative measures because it’s a little easier to see with relative measures. I’m also including B, which is generalizability index that I developed. It ranges from zero to one and one means that the sample isn’t exact miniature of the population on these covariates. 0 means they like are completely orthogonal to each other and. Chip in its the index is highly related.
to measures of undercoverage and how and
the performance of reweighting methods.
And then the mean are meaning the ratio
between the ratio between the
standard deviation in the sample and
population across these five covariates.
OK, so this is what we get out of this,
and so I just want to talk through this and
I’m happy to answer questions if there’s.
I know there’s a lot going on here.
Really wish I could figure out how to do a.
Pointer.
I don’t think I can point out that way.
OK, so OK.
So what I have going on here is the number
of sites randomly selected is left to right?
So on the left is the D optimal sample, meaning the whole all 41 sites were actually selected using a D optimal algorithm on the.

Right is the ideal for the average treatment effect. We’ve used random sampling to stratified random sampling and just like the sample an in the bar right right there that like right up there.

This Gray vertical bar is the actual study values for each of these. OK so you can see the actual study and then what I’ve got are three.
different lines going on here.

So one line that’s sloping down in solid is the relative D optimality value,

You know the highest value is if it was a D optimal allocation.

This is a ratio,

and then I’ve got the B index,

which is the generalizability index.

Is the other solid line going up,

and so, not surprisingly,

that’s increasing as we get to stratified sampling,

so these are going in opposition

so these are going in opposition

to each other.

Is what I’m saying and then this
relative average standard deviation.

Is this dotted bar line?

So what so the main message of this is that these are going in opposite directions right that?

The sample that is optimal for the average treatment effect is on the right.

The sample that is optimal for moderate are effects is on the left,

and so there’s there’s tradeoffs involved in these that what’s best for one is not best for the other.

But there’s other lessons in here, wow, so the the B index is,

which is a measure of similarity
between the sample and population, is actually not that bad for the optimal sample.

So these the sample is different from the population. You’d have to do some re waiting, but it wouldn’t be a tremendous amount of re waiting to be able to estimate the average treatment effect.

And so one lesson that you could think of it from. This is if you actually if we designed randomized trials to test moderators, we’d actually be in a pretty good space to test moderators.
00:35:56.930 --> 00:35:58.370 it wouldn’t be that far off.
00:35:58.370 --> 00:35:59.555 It wouldn’t be.
00:35:59.555 --> 00:36:01.135 It wouldn’t be terrible,
00:36:01.140 --> 00:36:03.390 and that makes sense because we’re covering so much of the population
00:36:03.390 --> 00:36:05.771 by getting her across a bunch of moderators that we can do so that we can re wait when in a domain in which there’s no act extrapolations,
00:36:08.592 --> 00:36:10.609 we have positive ITI we can re wait next.
00:36:10.609 --> 00:36:13.390 we can re wait when in a domain in which there’s no act extrapolations,
00:36:13.390 --> 00:36:15.140 which there’s no act extrapolations,
00:36:15.140 --> 00:36:18.290 we have positive ITI we can re wait next.
00:36:20.994 --> 00:36:24.240 if we look over at the right hand side.
00:36:24.240 --> 00:36:27.390 If we do, you know the trade off is.
00:36:27.390 --> 00:36:30.050 If I do select for the average treatment effect.
I do get a tremendously, you know I can select for the average treatment effect and do pretty well for the average human effect, but not do so well for that. For the moderators, and so what's ideal for average is definitely not deal for the moderates are tests. The actually did a pretty good job in terms of representativeness. You can see that top dot, but if you look at the bottom.
00:36:56.390 --> 00:36:58.594 at the other two dots you can see they didn’t do so well for.

00:37:00.800 --> 00:37:03.229 Being able to test these these moderators.

00:37:06.550 --> 00:37:09.142 OK, so in case that was not intuitive another way you could look at this is to actually just look at what these samples these features of these samples would look like.

00:37:11.420 --> 00:37:13.830 is to actually just look at what these samples these features would look like.

00:37:13.830 --> 00:37:15.785 these samples these features of these samples would look like.

00:37:15.785 --> 00:37:17.755 of these samples would look like.

00:37:20.210 --> 00:37:21.818 are population distributions.

00:37:23.550 --> 00:37:24.934 were sort of identified, and then at the bottom row is actually the study that they had.

00:37:27.341 --> 00:37:29.450 actually the study that they had.

00:37:29.450 --> 00:37:32.537 So what their actual sample looked like.
And then the middle is what the optimal sample would look like. Then I've overlaid on here. These are values, so giving you a sense if R is greater than 1, it means the sample is like the same standard deviation as in the population. If R is greater than one, it means I've got more heterogeneity in my sample than in my population, which improves my ability to estimate moderate are effects. And So what you see are a few things. One is in that the optimal sample is. It pushes things towards the extremes.
It’s pushing them towards the extremes to get endpoints which we know from basic experimental design, improved abilities. The other nice thing though, is a concern always when you’re doing experimental design like this is that you’re going to get your highly focused on like a linearity assumption that you’re going to your assumption that you’re going to your. Your ideal sample would have a strong linearity assumption to it, but because you have multiple variables an because not all design runs are possible. In the population,
you end up with these middle points
NOTE Confidence: 0.86
as well so you don’t end up with
NOTE Confidence: 0.86
only things on both extremes.
NOTE Confidence: 0.86
You end up with some middle points
NOTE Confidence: 0.86
which allow you to be able to estimate
NOTE Confidence: 0.86
nonlinear relationships as well.
NOTE Confidence: 0.86
Me and a Third Point with me.
NOTE Confidence: 0.86
You can see that you would just end
NOTE Confidence: 0.86
up with a lot more variation and so
NOTE Confidence: 0.86
not surprisingly, total students,
NOTE Confidence: 0.86
which, again schools studies,
NOTE Confidence: 0.86
schools and large school districts.
NOTE Confidence: 0.86
You can see this is a place where
NOTE Confidence: 0.86
there would be really a real
NOTE Confidence: 0.86
opportunity for a change that in
the sample this was less than one
an in the in the optimal sample
it would be greater than three.
But you can see this for most of
these variables that you could.
You could potentially improve your
power and ability to estimate things
related to demographics as well.
And in my paper I actually show that
because many of these are proportions,
you can actually also think about
student level moderate yrs because
proportions conveniently like the
variation in proportions at the
individual level as a function of
the proportion at the aggregate. And so you can actually kind of workout a way to select your samples so that you can. Estimate individual affects, not just cluster aggregates for those variables. OK, and so then the final point. I just want to make is that the other thing that this shows is that there’s real benefit to augmentation so. Maybe? You know, maybe I’m not going to be able to convince people to go switch to selecting their samples based upon extremes. But maybe you can convince people that they could preserve 5 or 10.
You know 10% or 25% of their sample for D optimality. So you choose. In this case it would be like choose 30 of your sites using stratified sampling to represent the population, and then look for like an additional class tenor 11 sites that might be more extreme that allow you to make sure that you can estimate these. These moderate are effects that you’re interested in. And you can see that doing so key file with these little lines you can see that doing so doesn’t have a huge
effect on the average treatment effect, but it does greatly improve your ability to test moderators.

OK, so just to wrap up my take home points today, I suppose would be that the design of randomized trials has big implications for ability to generalize. And that I think we, I think what I’ve seen over time is that people who are starting to pay attention to that, and they’re starting to think about how populations you know. What are the populations I would add as a side benefit of this is I’ve watched as people in asking people to scientists to think.
NOTE Confidence: 0.87828714
00:41:18.527 --> 00:41:20.219 about what the population is.
NOTE Confidence: 0.87828714
00:41:20.219 --> 00:41:22.253 It actually sometimes make some change
NOTE Confidence: 0.87828714
00:41:22.253 --> 00:41:24.300 with the intervention is because you kind
NOTE Confidence: 0.87828714
00:41:24.300 --> 00:41:26.510 of have to realize like is this is this.
NOTE Confidence: 0.87828714
00:41:26.510 --> 00:41:27.950 If this is the population,
NOTE Confidence: 0.87828714
00:41:27.950 --> 00:41:31.190 is this the right intervention?
NOTE Confidence: 0.87828714
00:41:31.190 --> 00:41:33.790 The second sort of point I would say,
NOTE Confidence: 0.87828714
00:41:33.790 --> 00:41:36.346 is that if we want to sort of estimate
NOTE Confidence: 0.87828714
00:41:36.346 --> 00:41:38.189 and test hypothesis and moderators
NOTE Confidence: 0.87828714
00:41:38.189 --> 00:41:40.797 that we would be wise to actually
NOTE Confidence: 0.87828714
00:41:40.797 --> 00:41:43.533 plan to do so and to think about how
NOTE Confidence: 0.87828714
00:41:43.540 --> 00:41:45.390 to have better design sensitivity
NOTE Confidence: 0.87828714
00:41:45.390 --> 00:41:47.240 and statistical statistical power for
NOTE Confidence: 0.87828714
00:41:47.294 --> 00:41:48.854 doing so instead of waiting until
NOTE Confidence: 0.87828714
00:41:48.854 --> 00:41:51.285 the end and then the last point is
NOTE Confidence: 0.87828714
just that this augmentation approach indicates that we don’t have to be perfect at this like that, we could just, you know, use do this for part of our sample. And we would be better off and then I guess I would say maybe my general philosophy in all of this design is that. What I’m trying to do is to get people to think differently and plan differently, and by doing so, even if you don’t succeed 100%, you’re better off than you would have been before, and you’re now able to be in the realm in which you have positive
ITI and heterogeneity, and you're able to actually use statistical methods. To get better estimators at the end.

Thank you, this is all my contact information and this is the paper that this talk is really about. I'm happy to answer questions.

I think that's really nice talk and thank you for being so inspiring. And maybe let’s open to questions and maybe let’s open to questions if so, please speak up or, you know,
send a chat. Either one is OK.

And if not, I can go first.

'Scause I do have a couple of questions.

So, so first of all, I think you know there is a constant tension.

Of course, like you know when we work with really large trials in the healthcare system,

I think there is a tension between how do we better represent the population of interest? Because we want to get effectiveness

But also I think there is a concern on you know how to really better engage these large clusters,

large healthcare systems or large clinics,
NOTE Confidence: 0.9289141
00:43:42.000 --> 00:43:44.010 etc. And so I think.
NOTE Confidence: 0.9289141
00:43:44.010 --> 00:43:45.625 People end up getting convenience
NOTE Confidence: 0.9289141
00:43:45.625 --> 00:43:46.917 samples because that’s reality.
NOTE Confidence: 0.9289141
00:43:46.920 --> 00:43:48.922 Even though I do believe that there’s
NOTE Confidence: 0.9289141
00:43:48.922 --> 00:43:50.910 so much more to improve because
NOTE Confidence: 0.9289141
00:43:50.910 --> 00:43:53.046 they’re spending so much money right.
NOTE Confidence: 0.9289141
00:43:53.050 --> 00:43:54.670 And then in the end,
NOTE Confidence: 0.9289141
00:43:54.670 --> 00:44:00.826 you know they may be answering a
NOTE Confidence: 0.9289141
00:44:00.826 --> 00:44:02.738 different question if they have a
NOTE Confidence: 0.9289141
00:44:02.740 --> 00:44:04.522 like you know there are some
NOTE Confidence: 0.9289141
00:44:04.522 --> 00:44:06.300 disparities in their sample selection,
NOTE Confidence: 0.9289141
00:44:06.300 --> 00:44:08.136 so that you’re basically not covering
NOTE Confidence: 0.9289141
00:44:08.136 --> 00:44:10.088 you know people with maybe more
NOTE Confidence: 0.9289141
vulnerable conditions etc in your study,

but you wish to answer questions.

What is population?

So I feel like all of this very,

very relevant, at least to my work.

And so I really appreciate you know this

aspect of how to design styles better.

one of the questions I have

is that generally,

you know we may not really know priority

what the effect modifiers are in planning.

The trial that we may have

not enough knowledge amount.

So how does that generally come into

the discussion in the design stage?

Is it the tradition that in educational
studies we have a lot of prime knowledge on what these effect modifiers are or? No, so I think this is actually one of the hardest parts, right? Like I just laid out. Sort of, if we knew what the why zeros and Y ones were, this is what we would. You know this is that would be optimal, but I could be wrong on what those are, right? And I don’t know. I mean, I think so. There’s sort of what I call the usual suspects in education,
which are like race class and gender, which are really more of concerns about disparity or about closing achievement gaps in various ways. And so those in depth and urbanicity I would add seems to be something that people often like. What add into that as characteristics. Those are the ones that people most often use. But the and those are available in population data, which is the other thing that your limit your. A real limiter is what is available in the population, sure.
What I gather is more likely to be a moderate
are or something like baseline achievement,
right?
So if my outcome is achievement then I would,
I would think that what the
achievement is baseline in any
achievement of these places would matter.
That’s harder to get an education.
I mean that information from places,
so there’s been some work trying to
equate tests across states.
I guess that they do.
Sometimes
they use gain scores just to subtract off
that baseline achievement, right? They
Yeah, exactly, but the problem is that if you wanted to use state tests or something, there are different tests in every state, and so there’s all of these equating issues that go in with it. My guess is that implementation is another one that people often come up with is coming after assignment and so it’s really like a mediator. But if you think about often, you think implementation may be part of what is leading to treatment effect variation,
then you can kind of think well what. Affects implementation and so people can sometimes think a little more carefully about what affects it's probably. You know, it's probably easier to implement this in schools that are like this. Then schools that are not like that. You might try to find various measures of this for the implementation that sounds more like a. It’s sort of a version of multiple treatments, and it’s a violation of the suitable condition, probably.
Yeah, yeah, exactly yeah.

So it gets tenuous. Yeah, I don't have this is, you know, when I first started doing this work I was like, well assuming moderate yrs and assume a population moving on as a statistician. But actually those are the two hardest things when working with people in planning these trials. I'll give you an example though. Uh, like a positive case which was. I was part of designing something called the National Study of learning mindsets,
which is we randomly sampled 100 high schools in the US, and then the students. There were. Ninth graders were in the study and so 9th graders were randomly assigned to either using a computer based intervention to a growth mindset intervention or something that was not growth mindset that was just sort of control condition and. And in doing that we had the social psychologist I was working with had a lot of questions like we had a lot of hard questions about these.
moderators and they had a lot of theories about what they might be like. So we oversampled like we.

Looked at for example, proportion of students that are minorities in the school and then. And when we started we wanted to stratify on that as well as school achievement as well, and so we needed to be able to cross these in a way in order to. In order to D alias these trends and so they could estimate one without, you know, without estimating with separated
So a lot of it. So I mean, in some places people are much more better, thinking about this, I think some fields are better at thinking about these mechanisms than other fields are, but yeah, it’s really hard. So my other other than my like standard set, you know, race, class and gender is, I often ask people to to think about. Watch what variables might just be related to other things, right?
That if you could.

If you can think of it as like I ultimately want to test moderators that I don’t really know exactly what they are, but I need to get variation in them, and that means probably by getting variation in something else. I’m going to get variation in those as well, I’m going to get variation in those as well. The size of your site, you know, I think, is one place where you know an education. You can see that everybody’s in very large sites.
The variation of district size and school size? It seems like has to increase variation of some other things as well. Agreed, agreed. Yeah, I think another aspect why I so appreciate like the aspect of effect modifiers is that it really is a way to move forward with information from Co. Buryats and then when we talk on 80 in a randomized study, we often ignore covariates and then just hold that the unadjusted analysis provides unbiased estimates, even though that may come with
So by really talking about effect modifiers, we somehow incurve those information, but perhaps even in the estimation of the average affect, which can increase precision.

Yeah I haven’t questioned, so I actually have two questions, so seems you’re interested in both individual level and cluster level moderators right? When you have cluster level moderators, how does that work with the augmentation design?
'cause you mentioned that in the orientation design, you might want to pick like 10 or 30% of the sides. An kind of like choose them samples from those. But how do you choose those 3%? You choose those third percent with respect to the cluster level modelers. You could do it with respect to either. You can do it with respect there because it depends the way you enter them into the model so. You work out so you can work out that if I'm interested in the individual level.
Moderate are that that what I need to do is I need the I actually need to include as a covariate the interaction between like X an 1 -- X. That’s what I included here as the covariates. I’m ‘cause I want to increase the variation within sites right? And so you could do it either way, because what it’s doing, what the augmentation approach does? Is it assess is how much variation you have in those 30 sites already. And then it looks for possible design runs, meaning other samples. Other places that would greatly improve that.
And it just doesn’t algorithmically, which is nice. The that I would say I should add an extra benefit of this is concerned with all of this sample recruitment is that there’s non response. You’re never going to get, you know it’s not like I can just say like. Here’s your. Here’s your like 40 sites go ask then and they’re going to say yes, but with the augmentation approach if somebody says no you can like throw that out and then go look for it like what’s the next best alternative.
00:52:21.463 --> 00:52:24.076 so you can keep kind of iterating.
NOTE Confidence: 0.8542276

00:52:24.076 --> 00:52:24.540 So,
NOTE Confidence: 0.85717666

00:52:24.540 --> 00:52:26.170 so in our current application,
NOTE Confidence: 0.85717666

00:52:26.170 --> 00:52:30.114 I think the attributes are all cluster level.
NOTE Confidence: 0.85717666

00:52:30.120 --> 00:52:31.332 Information right summary statistics
NOTE Confidence: 0.85717666

00:52:31.332 --> 00:52:32.849 yeah yeah, well that’s what
NOTE Confidence: 0.85039884

00:52:32.850 --> 00:52:34.042 I have right here.
NOTE Confidence: 0.85039884

00:52:34.042 --> 00:52:36.207 That’s in the in the slides but
NOTE Confidence: 0.85039884

00:52:36.207 --> 00:52:38.037 I didn’t include in here though
NOTE Confidence: 0.85039884

00:52:38.037 --> 00:52:40.186 is like you could it’s but it’s
NOTE Confidence: 0.85039884

00:52:40.186 --> 00:52:42.544 in the paper is you could also do
NOTE Confidence: 0.85039884

00:52:42.544 --> 00:52:44.054 this with individual level only.
NOTE Confidence: 0.85039884

00:52:44.060 --> 00:52:46.058 For proportions mean because just because
NOTE Confidence: 0.85039884

00:52:46.058 --> 00:52:48.298 the proportion works out that you can get.
NOTE Confidence: 0.85039884

00:52:48.300 --> 00:52:50.112 You can think about this with
NOTE Confidence: 0.85039884

00:52:50.112 --> 00:52:51.675 the same statistics you would
get at the cluster level.

You can’t get the variation you can with a normal like a continuous variable.

I can’t get the standard deviation.

Insights I can’t do that, right, right?

Also, the other question is about so it seems like all these designs are under the assumption that you’re interested in all the moderators, interested in all the moderators, not like you don’t have like primary moderators that you’re interested in.
estimating the moderate effect on and then you have a couple of them that. I mean, if you can. So I mean, what’s great? I mean, I think about this like this area is that it’s been so richly developed in this other sort of design runway is that you can actually add weights. So you can say like I’m more like or more interested in this variable than that variable, and it will focus. You know it will focus on one variable over the other. Because you Can you imagine like that D matrix. The determinant of S.
You could just add weights into that.

So if you add weights into that then you can start looking at the determinant of that weighted version.

Right, so you would add weights in that matrix and optimize that.

Yeah exactly,

if you add weight so that some of the Kobe rates are getting more weight than others.

So I guess just maybe more precisely,

I think the D optimality criteria.

Shouldn’t that be the X transpose V universe in general?

Just because you’re working with
clustered randomized studies so that the outcome correlation is somehow included in that variance? Is that what the algorithm is trying to get in general for? Yeah. Inverse, yeah, it’s the X prime X inverse, which is the covariance. Yeah, but really not so it you don’t. You don’t need to have the variance matrix of the outcome. Exactly, you don’t need to have the outcome, it’s all about the inputs, right? But that’s, which is why you can do it in advance, right? So it’s all about the Android just nicely.
You can leverage population data that you have totally. And again, I assume in all of this that like there’s measurement error and that you know you can just sort of assume that like you’re not going to get it exactly right, but my baseline comparison is always what are we doing now versus what could we be doing an like frankly anything. Any you know it looks to me like we have fairly homogeneous samples and have fairly homogeneous samples and that any effort we can make to increase heterogeneity is an improvement.
but let’s see if we have any final questions from the audience.

Alrighty, if not, I think you know I’m, I’m sure if you have any questions that petition will we have to answer them offline by email?

So thanks so much. Again, bath. It’s really nice to have you and thanks to everybody for attending or see all of you. Hopefully after the break so have a great holiday. See you later.

Totally not master connect Totally not master connect, thanks again. Talk to you later. Bye take care.