STD Session 4 (2)

**Karthik C:** [00:00:00] We get teacher feedback, right, and endowments for all of you to rate me. It is, it is the class properly, it is correct, yes. You give me a feedback. Why is that feedback required? Why is the feedback required? Correct on the feedback, he says. Any other, uh, view?

Second from right, last guy. What's going wrong, man, black shirt? You're not even listening. Right, I've got a couple of TA's sitting. Okay, if you, uh, deviate, you're not listening. They'll make a note and cut your , right? So you're behaving like children. I'm gonna read you. Okay, so back to what I was saying.

Yes. The current state, he's saying track the current state. Is that the intention? Right? Why is the feedback required? You go to a hotel, you have a cup of coffees, valuable. What do you tell the guy? Communication. He says, no,

bring [00:01:00] some change. Okay. That close it? Yes. What's your number as usual, right? I'll give Mark for participation. You hold CS 23 B? 23 I one zero. One zero. Okay. What's your name, right? Satan. Right, so he's saying Satan is saying to bring about a change. Why? About a change to maintain a set point. What is set point?

I have to come, come to class, right? If I don't show up to class. You done? Give feedback on what you are doing. If you don't correct your answers, it's on fine, right? So that feedback loop keeps me in check if nobody's asking me if, if I'm just getting paid a salary, right?[00:02:00]

So guys understand you need minimum 85% evidence. All you can offer to lose is out of 12 sessions. You can miss one session. If you are absent for more than one session, naturally your attendance will fall below 85. Right? Don't come and complain later. Come and test it. Uh, I can't help it. Sorry. Okay. If there is a legitimate medical reason, please apply to the portal and go to the academics.

Right? I am recording, right? Individually. Many of you are even giving proxies. I know. You are making note of that also. Many of you are doing all this impersonation, right? So I have made note of those problems also. Right? So you think I don't know all the mischief you are doing? I am aware of it. The mischief you're doing okay.

Don't think you're fooling me or fooling yourself, okay? So I'll be fair, capture it and tell you what I'll do at the end. Okay? If you fall short, imagine repeating the course [00:03:00] going into a fifth semester and coming and of you, right? So back to what I was saying, right? So

my train of thought, so I was talking about homeostasis, right? So you need a feedback loop. Right. To keep things in order. Right. That's the point. Now feedback loops. There are two kinds of feedback. Can somebody guess? What would be those two types? Positive and negative. Right. So what is positive and negative?

We'll see. Okay. We'll see one by one. So, before I proceed for the right two assignments so far you've given, there goes the third assignment. From now onwards, right, you'll have to do two assignments. Right. So, the data, whatever, you'll be sharing. Right. All the instructions I've put it in the slides. Is there anybody who still has struggled with teams yesterday?

Some. Some fellow sent me a reports after asking you for three weeks yesterday saying, sorry, it's a technical problem I'm sending, right? You have a technical problem for three [00:04:00] weeks and every right, so I hope all of you're there. I will simply ignore if you're not there on teams. Not my problem, ma'am. Ask you a number of times if you're not there.

That's it. Understand. 60, right? Over 50 plus of mar comes from assignments only 50 for right break up given. Okay, so let's come back to this. Basically, how am I going to asset them? Assess your assignment, right? I look at your presentation quality, okay? Some of your little scribbled something, it's not your read, right?

So make sure at least you type your assignments. Like if you don't have a good handwriting, at least please type your assignments. If you want something, understand the m. It's not easy. It takes us an entire day to sit and even correct your assignments. Okay, I along with the DS will be starting this week.

So a lot of work for us. Please make our job easy. So [00:05:00] write less, use illustrations, possible flowcharts, whatever, whatever you see fit. Right? I am not saying giving you a standard template. However you want to present data, it's fine. Right? Use normal templates. Right, I just did a couple of exercises in class itself, right.

I showed you, right, how not to do it, right. Do not write paragraphs after paragraphs. It is very difficult for me. It is not an Nth semester examination, right. So, effort and time spent by you in writing the assignment, right. That I can clearly assess, right. Whether this guy is even positive to this whole number.

Many assignments you are submitting, you have to go back, look at your document's title. Sometimes it says, new document to one assignment. See, I understand my, my plan. If it says New document one, your role number is not mentioned inside the document, it's not anywhere. Now I have to go back to a postmortem analysis.

Okay? Who uploaded this or this so and so, or this person, okay. Or this philosophical, right? Please don't do that. Give a proper title. Assignment one, right? Whatever is yours. 23 i 1 0 0 4, right [00:06:00] assignment.

First pages, top right or top left. Your roll over, put your batch. Patch the title, what is your team, team members. All the more easy for me to assess. See if you have to go back and check for every student right? It only adds to my pain, and what will happen, after i 4 hours? I will get irritated. Right, if I don't see them, right?

It affects assessment quality also. Ok so we know about this to be fair, but right? Let's not do that. That's what I meant by Even those tiny things, please take that. Okay. 14. Exploring the problem by talking to relevant stakeholders, right? Some quick preview I did right this week, and sit and go through all of your s, most of you, right, have not spent the time in talking to stakeholders.

Honestly, raise your hands. How many of you actually spoke to the stakeholders? Answer concerning your problems? Many of you, even problem shipments are problematic still. We have to go back and review. Okay? We give you feedback, but the [00:07:00] point is. Many of you have. Not even, it's the obvious from, it's really apparent from the quality of the work you submitted.

Sir, I, I didn't find time. Be honest, I'm not blame, not one hand is going right. At least now I get two, two ways of prayer. Enough to admit. Usually what happens is two ways to go and slowly I What, what is the, what is your honest struggle? You tell me. No problem. Okay. Why, why didn't you talk to any? You did you?

Oh, you, you were saying you did talk to state. My question was the opposite. How many of you did not talk to state? Okay,

so if you don't do that right, you'll have no context, no immersion. Even if you're paying a software solution, please. There's so many. It right? Is not for its with all IT account, talk to people, talk to our own alumni. You don't have to go anywhere, right? We [00:08:00] are going to talk about a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, Right.

Of course I'm not gonna entertain that. Right. Sometimes I'll get random mail, right? People ask for internship. I want an internship with you, right? Monday, eight o'clock, I'm coming. This is how they write for me, right? No empathy. Absolutely. I most, I'm most likely not, I'll not respond to them, right? But rather somebody says, greetings from so and so university doing class, and so and so.

I'm currently working on this problem. These are the resources I refer. How a small player, right? I refer these resources [00:09:00] and I'm able to piece together this much, but I'm not able to proceed further. I really wish, if you can give me some time in person or an online, just five, 10 minutes, will you please pass some time to take this discussion?

So I read that. I'll be like, okay, serious, fine. I'll give you understand, understand who you are. Mail even now I get mail.

Like clearly said, oh, please don't do that. And despite me telling in class, somebody's still doing that, right? You have to empathize with the user. But the key traits of a good engineer or a designer is empathy. You have to really understand what is your, your pain. Let me understand if you're a problem solver, what is that you want?

Right? That I really understand. Okay? So understand that. Please talk to stakeholders and the quality, right? So a lot more immersion is required. Please don't anything you. This is the third semester. In sixth semester, you have to work on [00:10:00] the flipkart. Okay. Let us quickly recap what we saw last week, right?

So, we said, complexity can be measured using a measure called variety. Okay. And, we said, given any system, the system has got to have a boundary. There are elements in a system which are parts, and each parts are linked to every other part. Okay. And the relationship can be one way, it can be both way, it can be turned on and off.

So, what is possible in the best case? If every element talks to every other element and if the relationship is, uh, it goes both ways. And if it can be turned on and off, what is the expression? Mathematical expression I gave you last week. It is, it is, something I said, 2 power k, right? So, it becomes exponential.

Okay, so I, so I have been, you have shared the presentation, please take note, right. So when you start off, right, you start, [00:11:00] when they are connected, right, you start with n e to the n minus 1 by 2, then it becomes, formulation becomes permutation, n e to the n minus 1. Then it becomes, when you can turn the relationship on and off, it becomes exponential 2 to the power k, right, it becomes huge, okay.

So typically, right, any system that can adapt itself to changing surrounding will have that sort of a permutation. Okay. So, it can be inherent to the object and can be desirable for its existence, especially natural systems, right. So, homeostasis is one example. It can also indicate the amount of information required to understand the object.

It depends on the observer. Okay. Please understand. Okay. I'll give you an example. Let's say, uh, what's your name? Shweta. I call Shweta. I say, Shweta, you have to make a mathematical model so you can predict weather for the next two days. Okay guys, listen, very important, okay, so I'm calling her and saying, you figure out, okay, so you go talk to a right, a climatologist, right?

You go [00:12:00] a psychologist, whoever want you go talk to which person, what? I want you to write a piece of code, right? That will tell me what is the predicted whether for next 48 hours, what she'll do. Okay? She'll go talk to a couple of people and they'll have their own way of looking at the system. What is the system?

The climatic system, right? Look at feather and how do you model weather? There are so many variables we just saw, right? So we do one, I taught you import, we do one duction model. We reduce, there are thousands of variables, differencing weather, so we reduce the variables into some manageable numbers. So probably you might say, I will take Dane values.

It's a reductionistic model. The model is not perfect. I know that prediction. That is what it's called. Prediction, I can say for sure. Right. It will become a prophecy. Yes or no? It's like predicting stock market, right? Which stock will go up. You look at a trend, right? You look at the company's, uh, economic [00:13:00] performance for the last 10 years.

Right? Then you say, Tata Futures will share. It's like that. But, will it perform? It's a prediction. It can also be wrong. Something may happen. Suddenly, Suzuki Vendor is a new model. Right? Might eat into Tata's. This happens all the time. Yes or no? So, it's a prediction. Prediction is difficult to predict. How do you predict?

You create a mathematical model. That model involves some statistical modeling, right? Which is a reduced order model, let's say. Right? You, there are thousands or hundreds or thousands of variables that will influence. But if I give it to Shweta, she will do one model. Let me take five variables. I give it to this guy.

What's your name? Akash, right? Akash, right? You are the right guy. Okay? So Akash, I give Akash, you predict whether. He may come up with, let's say another five variables. But the five variables which she picked and the five variables that she picked, the overlap, maybe just three. He might have picked two variables, which she did not transfer.

Or she might have picked two variables which you did not transfer, whose model is right. The answer is neither. Neither model is right? [00:14:00] Right. But which model is more accurate? Maybe one model may be accurate in certain time of year. Maybe someone is traditionally current. Maybe winter. Your model is, you understand.

So. The point I am trying to drive home is, when you make a mathematical model, it is, depends on the observer. Who is the observer? That is the point it says. Right? This is, depends on the observer. I am looking at something. You are looking at, okay, what do you see? I will give you an example. What do you see, man?

Just tell me what you see. I am pointing at something. What do you see? Huh? He is looking at the railing. What do you see? Huh? He is looking at my hand. What do you see, man? Huh? Push our handle, huh? Okay. Push label. See, it's observe dependent. He said railing, he said, uh, right. The handle. He's saying the, uh, label there.

So it is purely observe dependent. So I will look at a given scenario. My observation [00:15:00] will differ from yours, right? So because of my observations are different, my perspectives are different, the way I model and the way you model different. Now the problem is this is what happens generally when you. Try to solve a problem.

You as an observer, right? You will look at it from your own perspectives, which is biased by your cultural norms, right? Typically, you are an Indian, right? So you, that cultural influence is there. That's the first thing. Second thing, well, if you're a CS guy, right? You purely look at it as a data problem.

Okay? If let's say a biologist looks at it, they may look at it from a diversity standpoint. How can diversity that's. Somebody who's an , right? If you give him, he might give you a completely different prospect. Right? Now, what is the problem with this problem is there is no one single university agreed model.

If everybody agrees on a model, it becomes a law. What is law you? Ten second law of motion. It is a [00:16:00] law. Whether you see it, I see it. She sees it doesn't matter, right? So it becomes a law. Otherwise, it's simply a model. Mathematical abstraction. So, what is abstraction? What is abstraction? I am looking at the scenario, I am trying to put forth, right, with my own biases.

However unbiased I want to, I will end up adding some of my own biases. So I abstracted to a level through my eyes. If you do it, if someone else does it, right, they are going to add in their own flavor. So, that is why all these models differ. That is why if you go to Accumen or you, it will say something.

If you go to another app it will say you something. It will say, it will rain, 95 will say 85 Why is there a discrepancy? They're using a different model, right? Just because they got it right today doesn't mean they'll be right tomorrow. It'll change, right? These are very complex people, right? Understand.

So point everything. Understand this, right? Let's say, let's start with team. What is so important? How many of you know to make tea I not be the [00:17:00] test? Tea? I I can make some. Okay. Have you done tea? I tried baking tea on your own. Huh? When was the last time you met an account?

Truly. Okay. Okay. Anyway, explain the process of making

start.

Okay. Okay. You pull the drink first, okay. Okay.

Okay, so this is somebody, any volunteers, anybody want to describe how you make the anyone last page. Anybody raise their hands? Just tell us that. Any volunteers? Anyone else? Yeah, okay, yeah, got it. Sir, you[00:18:00]

got the ingredients. I'll give you the ingredients. Now start the process. Let's start making tea. So, how will you do it? Okay? Okay, see, again, right away. That guy said he'll put sugar last. He's saying I'll put sugar as the second ingredient. Yes or no? Wait, sit down. Right.

The point is, there is no one defined standard way of making tea. Yes or no? So he will say, this is the right way. Somebody will come and say, Chinese guy, if you go there, he will say, this is the right way. If you go to a Japanese, they do it like a ritual. Just go to YouTube and then say, Chinese, Japanese tea drinking ritual.

They'll go, sit, right? They'll be a proper kimono. they'll do. You lose your patience. Right? Culturally, that is how they drink tea. The point is this. Something as simple as making a tea, the process is not standard. The ingredients, right, might differ from region to region. Somebody might even put cream. An American might even put cream in tea.[00:19:00]

Right, this is a no no for us. They will do that, no. Right, so, first level, right? The first level, this is called first level abstraction. What is that? I'm observing somebody making tea. As a neutral observer, I'm standing and I'm trying to abstract, right? This is what we call first, first level, right? First to adhere to the real world situation.

Actual situation. What is the situation? The process of making team, right? So then we look at what is called first order abstraction. Then let's go one step further. Let's look at second. Second order abstraction right now. This is more important, right? Function. What is function of a team? We only look at these terms.

What does function mean? Can somebody tell me I give you a card answer? Is there on the board

a. So, you know, you have a system, you are talking about systems design. So, you have a system, what does function of a system mean? Purpose. Purpose, who said purpose? Right, what is your number? I, 1, [00:20:00] 0. 0, 1. What is your name? Nitin. Nitin, right, Nitin is right, right. So, what is purpose? Can I ask you what is purpose?

Yes, you are also answering, yes. What is purpose? We gave you a, What it is supposed to do? What it is supposed to do? The reason of its existence. I'll write down the formal definition, okay? Goal, goal, goal directed. The formal definition says purpose is goal directed behavior. Purpose is goal directed behavior.

Okay, what does this mean, goal directed behavior? What is your purpose here? Why are you here? Okay. You have a goal. So, your behavior is directed by that goal. Everybody follow this? Will you forget [00:21:00] this? So, next time if you, if you forget, right, what is your own number? P, yeah? 1, 0, 6, 5. What is your name? Right?

So, When I say purpose, the standard textbook definition goes like, it's goal directed behavior. What is goal? Why are you here? Right? To ask yourself. You are here to learn. That's a goal. Right? To earn a degree. Now your behavior, you are coming to class everyday, you are studying, doing assignments, listening to lectures.

That's a, some process, right? Your behavior is directed by the intent of you securing a degree. Now that gives you purpose to be here. Like that, every system Need to have any manmade system. Natural systems are different. Why is the tree growing? Why is the sun shining? We cannot answer that right? But any system that is built by human beings will have a purpose.

Why? Why is the fan there to so I [00:22:00] can be comfortable? Why is there a chance to sit down, face down? It's everything you wanna ask. Everything in this room, everything ever made by any human being will have a purpose. What is purpose? Go directed behavior. Now, that corpus, right, that is dictated by functions, many functions, right.

If you look at, right, for instance, if you go to a situation and if somebody comes and then if they see I am talking, ok, and there are so many people sitting and listening, what are they doing? There is some activity. What is this activity directed to? It is the, it is one function of the processor, you understand, right.

So, there are many, many such functions are there. So, what is the function of the processor? When do you normally have a tea, man? Last day, white shirt. When do you have a, normally have tea? Maybe when you have a headache. Or, or maybe? Stress, okay. Then? Let's say you are chill. You are taking rest. Will you have tea?

Or relaxation also you do, right? Or maybe you have a headache. Right? [00:23:00] So, what is the purpose of tea? Tea does not have a specific function. Right. So, health and rejuvenation. Right? That dictates its function. Right? Now, medium. How is a tea carried? It's a liquid, so I need some vessel to carry, right? I have a cup.

Glass, silver, T, and water, right? Then what is its form? Physical form. Black tea. Normal tea, right? So that's the form. What is its color? Is it form? Right? How does its milk? Then connect what is inside the tea. Milk, sugar, right? Water, so on and so forth. Then structure, what do I mean by structure? The proportion of.

Taste, the contents. OK, how much milk is there, how much sugar is there, right? That is the proportion, right, which is the structure of the tea. Then, what does that impact? That impacts the behavior. What is called the emergent behavior. Remember, last week I was talking about, right, you going to, Taj Gorham hotel having Rs.

500 rupees paying, or going to Khanda Gai, [00:24:00] buying a tea for Rs. 10 rupees. Yes or no, why would I pay Rs. 50 times for the same tea? Emergent behavior is different. If you go to Taj Coromandel, if he gives you tea, he's going to give you, maybe a small snack, maybe a small, maybe a slice of bread, maybe a small, right, sandwich, probably you'll get a sandwich or biscuits, right?

It'll be a small meal actually. So about tea, if you ask a British guy, right, let's have tea. In their mind, this is not tea. For a Britisher, right, if you go, if you tell them, let's have tea, it's 5 o'clock, let's take talk, we can have a talk. Uh, So, we will make a, uh, we will make a, uh, a, a, a, a, an, a, a, a, a, a, an, a, That is the exercise that we call.

In a context we will make a, uh, an exercise. Why are you bringing biscuits and sandwiches? It is tea. This is a cup [00:25:00] of tea. This is tea. It is the first time I have a shot of tea. He said this ist like this is T No, this is right through. It's so confusing for, and actually right from India. What is that? T means what?

You have a custom that ist that is in my mind. Or you have one. Right? So that is why we say context is important, right Next. Right now you see here we are actually prob deeper, right? So this is second abstraction. Now this is what I want you to do in what? Right. Understood. This is fine. So please, commit these terms to memory.

Function. What is function? It is declared by? Purpose. Right. What is purpose? I just told you. Goal directed behavior. Next. Medium. What is medium? What is medium for a software? Software. For a piece of code. Python script. Python script. You need a PC. I need a laptop. I need a tablet or a, right, [00:26:00] cell phone. Some hardware.

Right. In which I can run the software. Right. So any software will need a hardware to run it. So that it needs a medium. Have you seen these spirits and all that? Dead people come through live people, they will talk. So they call it a medium. The ghost, the dead spirit needs a living human being to talk to somebody.

It needs a medium. The person who actually does the communication is called a medium. It actually means the exact same thing. Sounds like a very weird example but medium I hope atleast you understand. She is laughing. Right? And I didn't intend it to be a joke. Right? Sometimes atleast you will remember this right?

So every year, right, I can, if I say, you will start laughing. I tell them, right, Terminator and then I tell them cybernetics. Cybersystem, cyberphysical system. That they'll not know. They'll say, uh, that's what you are. Right. This is fine. So, Let us look at one more type. Whenever you look at a system, what are the, [00:27:00] first thing you should ask, what is the purpose of the system?

Any man, man made system has to have a purpose. What is the medium? What is its functionality? What is the form? What is the content? What is the structure? What is its emergent behavior? Okay. Right. Let us go to the next slide. Okay. Now, you look at this. Right. So, you see, you, you need to learn. Today, I am going to teach you lot of new terms.

Okay. So, we write it down. Okay. Okay, let's talk about computer networks. I have a no. A, okay. Nobody received a lot of inputs and it also gives a lot of outputs. So these inputs are going to call it in degree. Okay, so these inputs.

Okay, so[00:28:00]

if I add, I, I'm going to call it,

why is this important? Okay, so we have parts and relationships. Any system consist of lot of subsystems, right? Subsystem some parts, and those parts are linked to multiple, many other parts, right? And the relationship can be on or off. Right. It can be one directional. It can be bi directional. Right. So, in any physical system, the complexity is exponential.

Right. To mathematically characterize, we say any path at any given time will be linked to many other paths. If you look at one part in isolation as a local metric, what happens locally, if I say? Right. So, it is going to receive a lot of inputs. So, those inputs are, in other words, A is influenced,[00:29:00]

okay, A is influenced by something, PC, some other part, right? So that influence going inward and buying it in the, anything that goes out of the part under focus, right? Or the concrete is called an outing. Okay, fine. Now if I look at context, right, that is, let's say one noex influences function. Is it true?

Is it context is what we are in a classroom situation, right? So here, what is the function actually just to learn, right? Teach Now. This is a classroom context. How come this context is influencing my teaching? Right?

Think about this purpose. Does purpose influence function? Yes. Right now, purpose in in, in turn is influenced to buy behavior. And content actually influences purpose. How can content see? [00:30:00] Think about tea. What is the purpose of tea? We said health origin, rejuvenation, right? I start with the purpose, right?

That's the starting point. Now, that is influenced by content. It's confusing actually, if you look at it, the way the arrows are. I want you to think about it now. Because I don't start with the content, I start with the purpose. Purpose, how is purpose influenced by content? Can somebody explain? My purpose of drinking tea is to have a headache.

I don't need the content. Right now that is influenced by whatever is there in the, is what I'm saying? Is it even, does it even make sense? No. So think about it. I'll come back. That's my question. Exactly. That is the question I'm pushing. Should it not be the other way? Exactly. Whatever I need will, will dictate what can put, now I'm saying now, if I, based on this picture, it tells me whatever is going to dictate the purpose.

Right. Makes more sense actually. Right? So you have to think about it, [00:31:00] right? So let's look at principles of complex systems right now. Very important slide guys. Very, very important, right? Let's go one by four. Okay? So let's start with right, and we are onward, right? So you have a system at its right and what separates the system at its environment.

You made a boundary that separates the system and its right. Now, this system is an assemblage of dissimilars. This is the formal expression I gave you last week, right? You've got multiple parts and relationships, right? That's all sitting there. Now, what is the role of the boundary? Boundary, like I said last week, can control the flow of matter, energy, or even information.

So, whenever I talk about physical system, CS guys, right? You also talk about, you know about cyber, cyber systems, right? You write IoT, right? Basically, cloud, right? So, what is the boundary for a cloud? Is there even a, can you even think of a boundary for a cloud? Can somebody answer this question? [00:32:00] Cloud itself is an abstract concept, right?

Is it like a cloud? No. It's uploading, is everything going to clouds? No. Why did they even come up with the term cloud? Cloud computing, cloud storage, cloud processing. Why? Where did all these terms come from? Any ideas? It will be what? Expanded. Crazy, expanded. Any last page. I see somebody talking has flagship.

Can you please wake up? Stand up. Yes. What were you discussing with him?

Can't hear you, man. I saw your, saw the head talking, so Yes. Yes. So what is the boundary for, for something [00:33:00] like a cloud? Any answer. Any volunteers, I'll give you a mark. Internet is like an abstract concept, right? It's a, it's not a computer that they are connected. Where is the boundary for that? Firewall.

This is a very basic principle you have to understand. Firewall. Yes. Firewall. Yes. Firewall. Right. Good. What's your name? I1027. I1027. What's your name? Harit. Right. So you have a virtual wall. Every character is, technically the moment you plug in your RJ45, your computer is connected to any computer on the planet, technically speaking.

Correct? What safeguards your computer from attack from any other computer in the system? What safeguards any other system from your system attacking it? You have a virtual firewall, right? So that is what we say, boundary controls the flow of information also. Not [00:34:00] only matter or energy. Right now boundary can be porous.

What is porous? Your line of control, right? They're saying bond is porous, sir terrorist are coming, right? Which means what? I'm part of f Fencing, electrified, all that, soldiers guarding. But now occasionally what they, they cut, right? They infiltrate, right? So your boundary can be breached. Firewall breach, right?

So understand this concept. So what you, so it is like what is inside the system is sacred. You try to protect what is inside the system often. Here, what are we, why do we have walls? So there is no noise. People will not look outside. You not be distracted. This, right? And so if you put a boundary right, and then provide as much comfort as possible.

So you would sit in this direct, right? So that's what boundary environment, we saw purpose, we saw function, we saw, now we have parts and relationships. Right now, parts and relationships again and again. Right? I'm reit reiterating this point. Right? Your part itself [00:35:00] can be a subsystem. When I say part, don't think of a single part itself can be a subsystem.

It is like when you zoom in, you see tissue. Tissue, when you zoom in, you see cells. When you zoom into one particular cell, you see mitochondria, right? You'll have other constituents of the cell. If you keep zooming in, I'll say molecules. So, depending on the level of zooming you have done, what you consider as a part may be a subsystem.

Get, get, get Or in practice we say, most of the times, whatever we consider as a system of systems, right. Please note down this term. What we call as system of systems. There are many systems. It is too much for me to handle at that level. Ok. So I will, I will resort to abstraction. Cell. Ok. It is power also.

Mitochondria. I don't care what happens inside the cell. Cell is there. Tissue will behave collectively. There is a collective behavior. Right. Kidney is there. It will do filtration. Liver is there. It will do filtration. It will filter the blood. That's it. I don't care what goes on inside. So for me, kidney, liver is one part.

A, B, one element or one part. Understood? [00:36:00] So this is how you have to abstract. Right? So even when writing a piece of code, you layer the codes, right? Yes or no? You'll write multiple sub functions, right? And that in turn might have some ready made functions. It's like writing sine of theta. How many of you literally sat down and wrote sine of theta?

Have you ever tried doing that? It's one of the toughest coding exercises, actually, if you actually go down to the basics. How do you write it? Have you ever thought of it? Yep. You can do a cheating with thread and sync. I don't want cheating. I want proper. Right? It's not easy. Think about it. Right? So, otherwise you have to resort to storing.

That's also not. Right? How does the system do? How does Python? Python you just put some trigonometry you value. Sin of something, it gives you. How does it do that? You don't ask the function. Yes or no? So, you stop at that level. But if your, if your job itself is to figure out sin of theta, sin of theta becomes the boundary.

Understand? Okay. Then you probe in further, that is your system. So, right, so how, these are all flexible concepts is what I am trying to tell you. Whatever I am [00:37:00] covering, right. So it depends on, it's like a microscope or a binocular, depending on how much you zoomed in or how much you zoomed out. Right, so far fine.

And, importantly, right, so the behavior, right, emerges from interaction between the system, right, the circle and its environment, right. And it is heavily influenced by the context. Right, right. Okay. Look at this picture, right? If you look here, there are, of course, a lot of parts are there. It is only out degree.

Look at f, e, and T, right? If I look at f, e, and T, there are, they have out degree, right? Look at the term, right? Anything that goes on, we call it out degree, right? These things about out degree, and if you look at ga, A, B, C receives. And then, you can write down your, if you want [00:38:00] to write down your, you know, your, your I think it is at one level.

Right. I am classifying another level of parts, which has got both in degree and out degree. Right. That I classify it as at another level. Right. So, the direction of arrow is important and this leads to some hierarchy. Ok. Why is this important? Right. Let us go back to what I was discussing. Let us look at blood sugar.

How is your blood sugar controlled? You have got pancreas. Right. When there is lot of glucose circulating, what does your pancreas do? It secrete insulin. Right. That is injected into your blood stream. Right. That will actually bring down your glucose level. So what is happening to your pancreas? There is something signaling pancreas saying, all right, blood sugar is spiking, release [00:39:00] insulin.

So your pancreas secretes and then it injects it into your blood stream. So it means pancreas has got both the in digity and out digity. These abstractions are what I am saying, right? So, if you have a piece of code that only gives out but does not receive any input, it will be at a level 1. If you have elements of a code, parts of a code which does not receive any input from anything else, it only gives out.

Okay. And if you have pieces of, right, for instance, right, certain modules which receive and give out, in a physical system I just gave you the example of an organ, right. So, they are at one level. So basically, the parts that have no integral are at another level. This defines the hierarchy. Right? So, that is an important thing.

So, we are looking at what are called principles of complex systems. What are these principles? So, specifically right, we have to look at [00:40:00] stimulus and response. I started today's lecture with stimulus and response. What is stimulus? Room is pretty hot right now, right? I wish I had worn a like a half sleeve shirt today, I thought okay.

I took the thickest possible shirt from here, right? It's actually burning. Now the stimulus, I was expecting some stimulus. So I thought, okay, today classroom is going to be cold. What happened? The stimulus stayed opposite, right? It's burning. Now, what is my response? I'm profusely sweating, right? Why am I doing that?

I am trying my best to adapt to a changing environment. Environment will change, right? For instance, okay. Let us take example of a nuclear reactor. Okay. Let me put your, uh, picture. What is your name? Parthesh

is taking two seconds to tell his own name. What happened? It is taking time, yeah? Okay. So I have got a nuclear [00:41:00] reactor. Right? So we call it hot cell. What is hot cell? This is where your fusion, fission happens, right? So you take uranium, some heavy metal and you split it. All that is going on. So typically what happens?

Heavy water. Right? You know, you know that, right? You heavy water. That s pick up that heat. This heat in turn, okay? Runs turbine, okay? That connects the generator, that protect, right? This is what we, now let's focus here. There are, what are these things called? Control dos. Have you seen them? Can right with , all of you.

Right now, you need to have some sort of a feedback. Why feedback? What are you literally doing? You have created a bomb that doesn't explode. Every nuclear reactor is a bomb that doesn't explode. It's actually crazy to do. But when you, it has exploded in the past, like Fukushima, Three Mile Island, right? Uh, what are their names?[00:42:00]

Kiev, right? Russia and Chernobyl, right? So, so it's a bomb. If you don't have a feedback loop to control the bomb, it'll explode. It's that simple. So how do we control it? We need some sort of a feedback system. So, let us say you are taking your brother and brother's sister, you are putting them, you start pushing them, what will you do?

How will you push it? You will sink. He is saying correctly. Right? Ah, that is beautiful, right? Badri, I will put your number. I will put your number. Come over. That is it. Let us ask another question. Right? That is it. So, this is a resonance actually, that is the next word I was actually going to use. So, what are you trying to do actually?

You are moving in lock step, we call it lock step, in phase. Every subsequent push adds energy to the system, which means what? The amplitude is going higher and higher. If you keep doing that, what will happen? [00:43:00] Right? That is dangerous. So, what do you do? Initially when you start off, you start, then subsequent pushes, what do you do?

You actually slow down the impulse just enough to overcome friction. Overcome the aerodynamic track and friction in the H, yes or no? All of you understand this basic physics right here. You are actually, you are doing what is called as a negative feedback loop, okay? Usually we start off the positive and uh, negative.

So this is a negative feedback, right? We'll see how, how this is negative feedback. Then I'll,

when you start off. You want every subsequent amplitude to grow, yes or no? Otherwise what? Nobody likes to speak like that, right? You want to, like, really move. Which means you have to actually add energy. In other words, you have to amplify deviance. Repeat after me. Positive feedback amplifies [00:44:00] the other band.

Let's start again. Positive feedback. Positive feedback. Amplifies. Amplifies. Deviance. Deviance. Okay, so let's see what this is. What is deviance? Deviance, . What is wrong? The swing staying put. Now, every time it's swinging, that's deviation from its push. I'm disturbing it. If I simply let it go, what happens?

It last eventually come to a strong. So that is exactly, I'm disturbing it from its Ethiopia, right? So I start out by starting to push this way. Right. I am actually Then what am I doing now? I just told you positive feedback. So what feedback is this? When you start amplifies, it's positive. Now, if I continue doing this, what happens?

Right? It'll be catastrophic, right? How do you, you'll harm the child, right? So what do you do after the child has said, oh, no, no, no, no. Right. [00:45:00] So, what do you do? You actually slow down. Now, you, you are actually swapping to negative feedback. So, if you look at this, right, so, it is there in the next slide, correct?

Negative feedback stabilizes the system, right? Repeat after me. Negative feedback. Negative feedback. Stabilizes the system. Positive feedback. Positive feedback. Actually, upsets the system. It makes it more deviant, deviant from the now, right? These are opposites, right? Both, we need both. But which, which one do we need most of the times?

Most Or negative? Negative. Negative. Look at the ac. There is a set temperature. If it keeps going, you all freeze. Right? Right. It'll be unparallel. So once it reaches a set point, it cuts off. It let the temperature rise again. Once it reach a up higher set point, it again starts working. So the temperature of room, if you actually plot, it's not constant.

Why? Because it's very difficult right? Time versus temperature. In this, if the AC was [00:46:00] running right? No, not, that's not what I'm talking about. Three. So what I'm saying is set point, I'm sending it at 26 degrees, let's say, right? 25, 26. This is the set point, right? So this is what you take your remote, right?

This is what you're saying. But does it mean the root temperature will stay at 26? No. It'll swing within a band, right? Let's call right upward 27. So, what will the compressor do, AC, right, initially the room temperature is very high, let us say it is at 30, ok, so it starts cooling, it has reached 26, it will not drip actually, it will, it will actually drop below 25 and what will the AC will turn off, ok.

Now, cooling, if cooling is stopped, what will happen to the temperature, it is rising, rising, rising until it is the [00:47:00] 27. So, if I measure the temperature inside the room, right, typically this is how it is going to work. You cannot say, what is the temperature of this room, my remote has said 26, but does it mean that it is made anywhere?

27 is what it says. Right? Within a band it will be spinning. Why? Suddenly 10 people leave, what happens to the heat load? Heat load reduces. So, temperature will actually drop. AC will actually run, less. This is why they say, If more people enter a room, right, as your current , why it has to run more, to pull more people.

You understand? Similarly, if I keep the set point very low, if you give it at 18, 17, or 16, some cases will go to 16, keep it at 16. What happens? It has to run even more to pull to that extent, right? So you understand. So this process of the AC trying to maintain a set point use as a negative feedback loop.

Got it. Everybody clear? Similarly. In a nuclear [00:48:00] reactor, I want the reaction happening very fast, right? In fact, I want it so fast because I want maximum energy output so I can generate maximum electricity, you understand, right? But there is a level to which, right, I can contain the radiation and the energy inside the heat, right?

I have got a cell, right, that, that, I have got the shielding, concrete shielding, lead shielding and all that. That has got a higher set point. So I will not allow the reaction to exit beyond a certain point. So what will happen? Once it reaches a certain temperature, I will allow the reaction to exit. Rods coming down.

Once control dots come down, what happens? Nuclear action goes down. Now what happens? Energy output will go down. Now what happen again? The control do has to again, okay, then the reaction speed, right? So it be doing this right now, a beautiful control system will actually try to tighten this barrier instead of 27.

If I have a good system, 26.5. Within one [00:49:00] degree I can maintain. Right. So those acs are expensive. Right? Your in can do that. It can make it even closer to what you want to maintain. Right. Got it. Negative feedback. Now let go back to the swing. What is the swing example all about? Initially I said all student feedback is required.

Why? And after the child reaches a certain. So, a, b, c, d, e, f, g, r, k, l, m, n, k, l, m, n, k, l, m, n, k, l, m, n, k, l, m,[00:50:00]

Every subsequent, every subsequent added cycle right, will actually increase. So I switch from positive feedback to negative feedback. Not this, everybody clear? Anybody who doesn't understand this, fine. So I've given three, four examples, right? Most of the engineered systems will need negative feedback, okay?

You, you'll immediately write positive feedback. No, you need negative feedback to stabilize the system. Right? Now, let's look at this. Okay? Now there are multiple feedback groups in the. System. How do I make by multiple feedbacks? Free feedback, one feedback loop. I have to stand, I should not follow you.

There is a stabilizing algorithm running in my head. So what is it looking for? It's looking at where my fitness is, right? If I go here, okay, there's nothing to step on, right? I'm talking to you. That is a feedback, right? I'm thinking that's feedback loop. Running something is in my body temperature. There is a feedback loop running, going so.

[00:51:00] This is the um, uh, The sequencing uses this, but it is, it is, it is not a simple thing. and many other chemical metabolisms, metabolic activities are also going on. Everything is reading back to you, right? So that way, right, let us look at one feedback. Right. This we call rules of interaction. What is rules of interaction?

Last class I said, right, this relation can be turned on or off. Right. Why does it require this? If I touch a wire, immediately what happens? It pulls, right? You just remove your hand. So, that time there is a signal pathway. Normally it is off. The moment I get a stimulus, right, there is a reaction. So, what is the difference between, [00:52:00] right.

What is the difference? Whatever is the desired outcome, take that upon a temperature, right. Difference is huge. So, the sweat more. Beyond a point what will happen? You faint. Why do you faint? Your body shuts down. It is one protective mechanism. Why? To keep you from dying actually, right. Generally what happens is, right, when you are, that is called hypothermia, you are Right?

You will actually, your metabolic activity will slow down. Right? Your metabolic activity will slow down. But, before people die, right, they will actually start removing their clothes. Because at one last attempt, your body, what it will actually take all the energy it will try to actually remove. Even in a very cold thing.

Read about it. It's a very, it's a crazy thing. Right? So there are a lot of these feedback mechanisms within your own body. Right? That ensures cell point, blood sugar. Your body temperature. The pressure between your intraocular, right? Otherwise glaucoma, lot of glaucoma, it low blind, [00:53:00] right? Because if you have pressure right inside your eyeball, if it exceeds or goes down, right, that causes change in curvature of your eye.

That can cause blindness. So there are none of these feedback loop that have to be perfect. Balance pH level of your right P level of your blood like this. There are many, many different thousands of.

Right. So I finish this and let us go for it, right? So let us look at the gender, gender principle, right? Let me start with negative feedback, right? Let's look at the loop. C-D-G-A-C in the picture, right? Look at, look at here, right? So if I, if I take C, D, C, look at the positives and negatives. Okay? Only focus on 14, okay?

C, C, D, G, a, CI will start with C. So C is one. There are many parts and relationships. We are only focusing on parts and relationship of the loop. This loop, okay? If C increases [00:54:00] for whatever reason, okay? What will happen to D? They're positively correlated. C increases, D will increase. Okay, so C increases, D increases.

B increases what happens to G? Positively correlated. So G will increase. Now G and D, how are they correlated? Again, they're positively correlated, so G increases a will also increase. So, A and C, you see, there is a negative curve. So, A increases what is expected of C, C will reduce. So, initially, what happened?

Temperature of the room goes up, that causes a chain of events, ok. Finally, the last part, its increase will actually reduce C, ok. Now, let us continue. C is decreasing because of increase in A, C is decreasing, what happens to D? D will also decrease. B is decrease in water level G. C will also decrease. G has decreased what happens to you?

A will also decrease. Now what happens to C? A decreases C will increase. Now you see how [00:55:00] this would be self stabilized. In other words, count the number of negative signs, right? If you, what number of negative sites? Usually it is a negative feedback loop. Now look at positive feedback, right? Look at loop. C, B.

A, C. Start with C. C increases. It is negatively correlated with B. C. Increase what happens to B. B will. Decrease P decreases what happens to A. A increases. A increases. It's negatively correlated to C. What happens, right? You see the problem? There are two negatives. So in a positive feedback loop, the number of negatives I assign to be given, right?

There are two negatives in a negative feedback loop. The number of negatives that should be, or right. Simple rule, or if this is confusing, just use the logic I just told you, everybody following this, it's easy, right? Right. Once you think about, it's pretty easy now. There is one more kind of feedback. It's called self referential.

Okay? Self-referential, or what is called recursion. Recursion looping. You've seen, right. Recursion algorithms. Right? So this typically we don't use in engineer, [00:56:00] it's more for philosophy, right? But a part that is referencing, referencing to itself, right? It comes there, which is most important to us. Of the three loops that I speak of, mostly it is that negative feedback, but self regulated feedback is essential.

But I put as. Sometimes need positive feedback. Where is this useful? Where is this useful talking signal is going. This has to send out a signal, so it has to amplify the signal as much as possible. So the signal output that goes out of the transmitter in my pocket, right? The signal output has to be as high as possible, as much as the battery will belong, yes or no?

So he said resonance, right? So similarly the receiver there. You will need at the maximum possible amplitude. So both the sending and the receiving, right? I want to amplify the signal that I am sending. And similarly, right, I want to amplify the gain there. [00:57:00] Yes or no? So again, these are some rare examples where you need positive feedback action, not negative feedback action.

Here if I try to limit what will happen, right? Sometimes they might run, they might run, they might switch from one to other, you understand? Like the swing example I gave, right? Okay, so always understand. In engineering there is no absolute right. There is no absolute wrong, right? Repeat after me. There is no absolute right.

There is no absolute wrong. It is always relative. The question you should ask is, it depends if I ask you something, where is this useful? Right? Is this a good thing or a bad thing? If I blindly ask you an example, is, uh, positive feedback good at all? What will your answer be? You don't blindly say it's bad.

No. So the proper answer is, it's contextual dependence, right, if you can think of another example, right, swing is what I can think of, the swing happens, if you can think of another example, it's all the more better, right, so let's take a 10 minute break, right, I'll quickly summarize, then we'll [00:58:00] go and then start constructing the discovery matrix, right, today is a very important class, right, so let's, I'll go a bit slower in the second, second session, right, so time on my watch is 3 7, right, let's get back in 10 minutes.

Yeah. Yeah.[00:59:00] [01:00:00] [01:01:00] [01:02:00]

Yeah.[01:03:00] [01:04:00]

Also, we'll talk. Break the tires. The ball will be there. Play it for half an hour. Drink. [01:05:00] Cutting. Drink. Be there. You want to use a bladder? Use your finger. Use your finger. Let's take off.[01:06:00]

friend. Good morning to all the nation.

Guys, wake your friends up. Wake your neighbor.

Probably I should have a siren. Students, [01:07:00] settle down fast. See, we have a lot of ground to cover. Already I'm going very slow. I still have to cover a lot of Go faster. What's the address, man? Okay, ten minutes over. He went out. Guys, sit straight, man. Sit directly. Don't sit in the stumpy posture. Sit. Sit direct.

Imagine my partner. At least you can do this, right? My teeth are killing three hours stand. It's run easy,

right? So, right. So make recap, what have you. Can you quickly summarize it for me? Your name,

Angela, can you please [01:08:00] summarize what have we discussed in last so far? Let's start from the beginning. Feedback loops is just what I covered last. We can look, look, look through your notes. What did we start with? We started with parts and relations, yes or no? Right? Look at system, what is a system? System needs a, boundary.

System needs a boundary. Boundary can permit or block three things. What are they? I told you three things. What is a system? A system is a assemblage of, right, dissemblers. Right. And we also said, guys I am repeating, right, often, right, these things might sound easy, right, but this is all abstraction, right.

The difficulty about this course is, the course itself is not difficult. Often if you ask any student, right, this is the fourth year of teaching, ok, any student if you ask, right, did you talk to any of your seniors about this course? [01:09:00] Right. Generally if you talk to students, right, the first thing they will tell you is, of all the design courses, this is the most difficult course.

I can't make rid of data of this. This is the feedback you'll get. Recent being, right, I'm introducing to a concept which are not familiar, yes or no new. New terms. I'm using new nomenclature. In fact, I'm asking you to think differently from J. In fact, many things, right? It's not rote learning, right? It's not like differential equation for differentiation on set procedure.

Everybody can follow that. That's easy, right? So. So, the point is right, a course like this, right, even if we give you all the slides, if you do not properly listen, put down right, it is very difficult, you will forget, right. That is why I keep recapping over and over again, right. When I started learning this course myself, right, I spent believe me 6 months going through all the material, reading many books, ok.

You would get to a point where I can actually teach you, right. I myself will forget some of the concepts, right. Even though, unconsciously I will be using the principles I am teaching you, understood. [01:10:00] So, Let me quickly recap, right? So, we started with defining what is a system, right? It's a collection of multiple parts.

There are multiple, there are, there are relationships. I am going to talk about network. What is the difference between a system and a network in the upcoming class, right? Let's not bother with that now. So, if we have multiple parts, these parts talk to each other. Now, any part, okay, I've just deleted it, right?

Any part that has multiple parts, Sending out information. What is that called? It's a out degree, right? That goes out of that. Anything that it receives is called in degree, right? Take the summation of it. It is the total degree, right? Just remember this now. System needs a boundary. Why do we need a boundary?

You need to isolate it from its environment. Okay, Angela, right now this boundary can permit or block three kinds of things. What are they? Energy, information, or matter what is. This is a porous boundary, right? I can open and close the door, so there is exchange of matter, physically people [01:11:00] come and go, air is coming in, energy is also coming in, light is coming in, right?

In terms of information, may not be applicable to this scenario. But if I talk about information, what is the example somebody gave, right, somebody spoke about? Firewall. That's a, right? That's just a construct, right? It's a virtual boundary. Yes or no? So you have a virtual boundary which is a firewall that permits Or lots information flow.

That's a boundary, right? You have a computer system, you have a local area network, right? So that has got a firewall, right? So far find we also saw, right? Given this, there are multiple feedback loops happening in a system, yes or no. And these feedback loops is what actually maintains the stability of the system.

Those feedback loops are of actually three kinds, cursive, which are self-referential, positive and negative, which is the most important feedback loop. Negative feedback. Why is negative feedback? Negative feedback is deviance. D [01:12:00] Vance, amplified reducing. Okay, negative feedback. Is deviance reducing? Okay.

Positive feedback is deviance, amplify. Both are right. You need both. Okay, but most of the engineer systems, right? I spoke about the example of air conditioning, nuclear reactor, your own homeostasis body, right? Your computer fan, okay. I'll give you another example. All of you have got a phone. Guys, please, please sit straight, man.

Today, you're all too tired. I don't know. Don't you guys ever sleep? No. Huh? She's saying no. What do you guys do? Watch some sitcom, huh? Huh? What do you guys do? Sit straight, man. What do you guys normally do? I know you don't go to bed by 10, but I know. Huh? Maybe 12 at the earliest. Right? Listen, listen. Guys, listen.

Okay. So, we said, there [01:13:00] are three kinds of feedback loop, right? Negative feedback, I am going to give you one more loop. All of you have got a phone, right? When you start playing a game, what happens? Initially, the phone will be fine, right? After a while, it starts jittering, right? Slows down. So, what, what, what happens to your phone?

It thermal throttles.

See, banks will bring down your financial system. Electricity. Can you see without light fan here some, some patient in a hospital, they'll die. They have emergency backup. Maybe for one day they'll not A diesel generated then what? Right? So in any critical infrastructure, right? Electrical infrastructure is the most important.

If you look at specifically the node, why is every, you have a grid. Have you heard of this idea grid? What is a grid? Yeah, KA has got multiple power producing places, right? You go to Deep South Valley, they've got a lot of windmills there close by. They've got a lot of solar farms. You go to, uh, this place, , [01:14:00] they want a nuclear power plant.

We have nuclear power plant. You, you have thermal power plant, so you have multiple power sources. Everything is connected together. Why? Because if one power plant goes up, see summation, let's say one producers, just think about it this way, right? I put A, B, C, D. Okay. Each is a power source, okay? And my customer is also like this.

They are taking power from multiple places. If a goes down, let's say , there is some technical problem. Let's say they're producing a hundred megawatt. This is gone, this produces 300, this produces 500. Let's say this produces thousand. So come by. How much is that? Thousand 500,900. A hundred goes out of thousand 900.

Okay. Still since my MT grid is interconnected, right? I can run it at a lower capacity. Let's say this [01:15:00] guy goes right, that will bring down the whole system. So this is a critical one, not very contrary to what you are saying. What goes out as more influence than what comes in? Again, it depends on both what comes in and goes.

So you have to look at. Right. So this is what we call as, right. How tightly are the nodes grouped together by edges? We call it click, encode, decode. There are a lot of these arithmetical measures, right. This is a local measure. Globally you can have something called a clustering coefficient. That tells you how densely something is connected.

Then how many different influences does a node receive in degree, right? How many other nodes does it influence in return, how degree? Right. How long does the communication between nodes take? Right. From here to here. Right. This is the internet. How long does it take? So, local metric you can talk about.

What is the shortest path? That is what ping, gamers will know. Right. Ping. I am going to take the shortest path. If you look at the global metric, diameter or radius [01:16:00] is critical. Right. Now, centrality. This is the most important thing. Guys, listen. Right. So, some nodes in a network play a very key role in connecting the whole network.

Right. In this case, I Right. I'm talking about only the power plant, right? I did not talk about the power grid itself, right? So this will actually go to, we have a lot of substations, right? From there, only your user will drop, or not directly, like what I've dropped. This is wrong the way I've dropped it.

Draw from the power station. All this will go feed to the multiple such power stations, right? And your customers are also all over the place, right? Some of them will be customer. Right, so it'll be like this. So centrality, if we take out this, everything will that, right? So that is central. How central it is.

You can look at sort a banking thing, okay? There are two important centers globally. There is New York, right? They've got entire, [01:17:00] what is called the Swift, S-W-I-F-I-F, the Swift system. This is what the Chinese are still afraid of the Americans. Why? Any international transaction you do. The Americans are, they have a hold.

It goes to their system, they can actually choke. This is how they can have power. Nations say, I will shut down your banking system. They can do that today. China is trying to build their own bricks. Why do they have bricks? Currency, there is a lot of bricks. Currency, . Why centrality? American dollar is central international trade.

60, 65% of the international trade takes place with American dollar read vote. Right. So, that is central to the economic system. So, in terms of that, America, New York, as well as London, right, you look at Bank of London. So, these are central nodes to the international banking system. So, China has their own other central node in Shanghai, right, like this.

We have one in Bombay. Right. So, every country has a central node. [01:18:00] And internationally, if you look at the entire world, you will have most of this communication going through a place in UK, London. Right. Understood? Thank you. This is somewhat clear, right? Don't worry too much about specifics, right? If you understand the broad concepts, it's the same, right?

So power law, right? I, I'll talk about this now in upcoming lectures, right?

So, right. So we've come to the last part of the lecture. Now this takes some time, okay? Let me go very slowly, okay? Because I'm going to ask you to constraint something called a discovery. Thanks

before I go here, right? So give an example. I about the example oft, let that case up. White. White check. White check the dosing. Also, I'm gonna ask you, so this is the question I'm posing you, right? Yes. Stand [01:19:00] up. What's your name? Huh? Bargo. So Bargo, this is my question to you. I'm going to give you a tea, a cup of tea, because you need it badly.

Okay. So, what is your expectation of that one? It should be low. It should be given in a nice container. Why do you want appearance? Because it's important. Customer satisfaction is more important. It should be given by a good firm. Okay.

You should be better off. You should be giving me a girlfriend now. Yes. In the morning. After. At night. Enjoy my breakfast. That's not like you can tell me. Right? Now she's giving some Netflix, right? It should, it should refresh me. Right? Sit down. Okay. Now think of this, some common D brands. You say any common D brands?[01:20:00]

Three. You can keep saying hundreds of brands. Now, let's say I'm a businessman. Okay? I, I am. Let's say it C. Okay? I want to get into business, okay? It's a big market pizza. Perennial market. What is perennial market? Everyday people are happy it is not like, it is not like ice cream. Some are there sales will go up and it will go down, not like, like even in the sweater business winter it will go up.

Right? It is seasonal. Right? So I want a stable business. Right? If I want a stable business I have to pick what is called, right, fmcg. Have you heard of this? Fast moving consumer goods. Okay. Fast moving consumer goods. Chuma. Just, uh, I promise. Right. What are fast moving consumer goods? Toothpaste. Biscuit.

Soap. Which you will use every day. What is the thing [01:21:00] which you will use every day? Powder I need. Soap I need. Right. Detergent powder I need. Right. So, like this. Anything that you use on a daily basis. Toothpaste. Right. Toothbrush. Something you will buy every single day. Soap. This sort of a business is difficult to get into why there are established players, right?

If you talk about biscuit, right? , Bri is the ITC. is there, right? Very difficult to get a business. Now, let's say market is big. I as a business fund, right? I've got like, I've got 5,000 bucks. Let me invest, make I cannot send, right? Difficult to go convince a customer. Say, uh, would you buy it? Unknown brand, I'll not, I'll only buy

Right. That's the preferred brand. You'll have your own preferred brand. Yes. How do we break into that code? Right? So in other words, right, let's say you are writing a piece of software. Okay? Some new piece of code. How do you convince, [01:22:00] okay, let's say under established language. First there was

show some pictures and then come back to code.

I will call, I will make a B software, right, named after him. Right? Let's say he comes up. How does he convince everybody to use it? Made by Badresh. Made by Badrinath. Have some new functionality. No, I as a user will not use it. I'm not interested man. I'm comfortable with C, I'm comfortable with Java. Why should I?

It's paint, [01:23:00] right? New operating system, this guy invents. I don't care. Look at the flavor Linux has, right? The other day I checked, it is crazy. I didn't know, I knew Ubuntu, I knew Mint, and Red Hat Linux, that's it. And Susie, yeah, there's one. Camellia. These are the Linux versions I know. I actually went into their Linux distribution.

It's crazy the number of distribution they have, the derivatives they have. And if I look at the user, like, 5, Some of the versions like only 10,000 interviews. Why is somebody bothering to even write that pipe? Makes no sense to, right, but it is what specific functionality, right? Look at a wire distributor.

Everybody has got a open though, right? Why do you use Or min people are used. Tobin, that's closer, right? Why do you use that, that, that distribution, right? If I come up with my own version, you understand the problem. Any new software or operating system that I make, right? It's very difficult for me to work.

Convince you. It's like earning YouTube subscription, right? You start a new channel, you take a reviewer, take a Guruji, yeah, you [01:24:00] guys can follow somebody, right? That's just going on, like, he reviews all phones, right? He wants to start his own channel, who's going to subscribe to him? Nobody! Right? Or let's say I start a channel, no, nobody subscribes to me.

How do I convince you? Right? Which means, I have to offer you something. Guys, listen. I have to offer you something, which no other is offering. Guys, listen. Sit directly. Right? Try to make it as So, I am going to do a little bit of a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a, a. Right. So, understand this. Right.

So, point is, [01:25:00] any new service, any new product that I make, tell me, don't take us. So, what is the first thing I should do? I should do a market survey. I just asked you, tea if I make, right? Nobody is going to buy my tea. So, I have to ask the question, okay. What is the customer really want? Let me first understand that.

Let me understand the problem situation at hand first. Right. Then it will help me to actually innovate. I have to innovate, right? You, you come up with a new programming language. It has to, it better innovate something. Right. Which means it has to first understand what is that the user wants. Correct? Yes or no?

So, we are going to have a semi mathematical approach. You understand? It is not, it is not, I told you at the beginning of the class itself, the method I am going to talk is observer dependent. It will vary. He does it, if she does it, if I do it, right, if he does it, if I do it, if she does it, Right. It is going to be different.

Why is it going to be different? It is observable, right? That is why it is called log. Right? So we are going to follow a semi [01:26:00] mathematical approach to construct what is called a discovery matrix. Discovery matrix. Okay. All of you know matrix, matrix algebra, right? We are going to make a n by n matrix, right?

Last class we said. Right? Okay. So, the dimension of the matrix is going to be n by n, n by n. Typically, okay, maybe in 9th or 10th lecture I will actually show you a discovery matrix for a, what is your face in curve? A lot of drifting faces. Green shirt, yeah. Right? So, n by n matrix, what is the dimension? n can be anything, right?

So, I will show you something like order of 15 by 15. Okay. What I expect you to do for your problem statement is construct a matrix of at least 25, at least 20 to 25, and should be at least 20 to 25. Okay? [01:27:00] It should be at least 20 to 25. Okay? So you'll have 25 columns, right? So it'll take you several hours to construct this, okay?

You have to do it as a team. You have to discuss debate, right? Go back, read literature, and then do it, right? So one example, one case study I'm going to show. In fact, I'm going to talk about T. Okay? But if that is something you all know, right? So you take your own problem statement and you have to construct it, right?

So you have to check for, check the metrics for completion, right? And teach you the method. And I'll come back here. Can you go back? Next slide. Next slide. Okay. Everybody can see this. The last read the. Content purpose, right? 40. I hope the last guys, the last one can read this, right? At least. Can you read this medium structure form?

No. Okay, so, right, I'll [01:28:00] read it out one by one. So first what you have to do, what is the end counted? 1 0 3 4 5 6 7 8 9. 10 Oh. Ten nine. I've got a nine by nine roughly. Okay. The reason I put nine by nine, right? This itself is invisible, right? If I put even larger, one, can't even read it, right? So I have actually clustered.

This is not how you should do, guys. Listen for simplification. I've clustered. For instance, read behavior. What is behavior of a team taste, right? Nutrition, energy should be three separate columns. There should be three separate columns. I've clocked them into one, right? Just to keep that size on the metrics in your thing.

It'll not be.

So, what is the behavior of pertaining to that or if I am making a system, if I am building electronic system, somebody said they want to monitor UV, what is the behavior of it? It has to, right, collect certain amount of light, respond to [01:29:00] certain, that will be the behavior. It has to give a signal in response to UV fall, that will be one, you understand, right.

So, depending on the problem you choose, guys, I repeat. So don't sleep through this if you don't do this. This matrix is what we will do. I will use this to make snack analysis, right? There will be not a derivative work based on this metrics. If you don't get this right, any subsequent classes you cannot do.

That's why I'm repeating one and door again, right? I still have got an hour. I will go step by step, I'll go very smooth and keep repeating myself, right? So at least it just clearly in your head. So first thing is behavior. Take your problem and look at. What is the behavior that is expected, in other words emergent behavior, keep that in mind.

What is the emergent behavior of my product, you understand? What is expected of that? Right? You write that down. Why are you coming this late man? And you Raja. Come here. Wait, what?[01:30:00]

Right. So what is the expected behavior of your problem set? Right. So you ask that question. Right. In other words, what is the emergent behavior? Sorry, not the expected behavior, the emergent behavior. Right. So what is the emergent behavior? It depends on the context. Right. Depends on what I have and the context.

Environment, right. Which environment I am using the product in. That dictates the emergent behavior of my product. So you list out what For instance, I'm making a car. Car has to run comfortable ride, right? Should not gimme any leg pain like that. You can go on, so you can club everything and say, drive comfort, or you can say travel comfort, which includes air conditioning, vibration, so on and so forth.

If you're riding a piece of code, right, which means learning code, [01:31:00] how easy is it to code in that particular language? That is what ease of you. Or what we call affordance software. We call it affordance. How easy can I afford to learn? Right? So we say affordance, how easy. Got it. So first thing, what you're doing, t here I've given behavior as is nutrition and energy.

In your case, you have to ask the question, what is the emergent behavior? There's next. Then let's look at the next thing. Medium. If it's a software thing, now, is it going to be run? Is it gonna be run on cloud or is it, will it be run locally on my phone or on my laptop? What is the hardware I will use it, right?

That is the medium. Next is structure. Here we are talking about chemical structure, right? So, for your thing, when I talk about structure, how infrastructure of your software, right? Again, front end, back end, right? I have given example in the previous class. Please go through that. For OLAP, right, and for music, right, you can refer to that.

You can keep referring to the [01:32:00] previous, previous classes. Right. I put a table, I put card, all app and music. So if you have trouble with any of these, you can go back process, right? What is process for team making? It is the sequence of steps. Timer needs, steps, types of tools, tools, stove, et cetera. That is, that is what is required.

But for your thing, the process of building that software, piece of software or the product service system, whatever, right? Next context. So what is the context? Where is it going to be used? Who is your user? Right. Some empathy is required here. Purpose. Purpose is, what is it meant for? Right. What problem is it solving?

Right. Next content. Right. So, you put this both in column wise and row wise. Is everybody understanding? If somebody does not want to raise your hand. Everybody following? So, I repeat, what you have to do is, for T, I have given the example, so we start with [01:33:00] things like behavior, medium, structure, function, form, process and text, right, within which there are multiple factors you have to account for, because to keep the size of the matrix in a manageable level and show you as a demo, this we have put it in 9 by 9 matrix, in practice your thing may need more factors, right.

So, the number of, Right. Parts and relations. Right. For you, it may be higher. That is what I am saying. Right. So, if you do not, if you have confusion. I do not know. Ok. What, what structure? I am writing a piece of, what is the process? Go back to my previous slide. Refer there. Whole app is there. Right. I have given an example.

Go there. Refer to it. That will clarify things. Understood? Still, if you have confusion, you can come and ask me in next class. Understood? This is fine. Now, we have a blank. We have to fill it with. Right. You have to fill it with. Ok. Uh, 1s and 0s, okay, I will tell you [01:34:00] how to do that, okay, I have got the wrong slide, wait, wait, wait, I have got the wrong slide.

So guys, there is a small correction in the slide, ok. So, see when I post it, I will correct it and post, ok. Last time we did it in class, I just lifted it. Ok. All the 2, 1, 5, right, you see here should be only 1s and 0s. What I have actually put it, right. So 10 students said, ok, I will go one by one. Then it will make sense.

Look at the first thing, ok. Look at this. So I am going to ask, ok. I am going to ask this question, right, about out degree. What is out degree? [01:35:00] Medium is one thing. Now it is going to influence what? Medium is going to influence behavior, medium is going to influence itself, structure, function, form. So the total out degree is what I have written there.

Understood? Fine? So first let us ask that question. Does medium influence behavior? For a T, what is a medium? It is a cup. Does cup have any, does it have any bearing on the taste? Yes. Nutrition, energy. So, what you have to do is, right, my corruption is drifting. Watch your face, right. So, for a cup of tea, guys listen, guys listen if you do not follow you cannot construct but actually for your problem, you will find it very difficult, right.

So, is that clear? So, what I am saying is, When you start, sit as a team. You have to discuss and fill this chart. Ok, you cannot put 1, 0 as, as, as, as, however you like. Understand? You have to sit as a team. You have [01:36:00] to debate. One guy will say, no, no, no, medium will have an influence. I will say medium will have an influence.

How? If you take a earthen pot, right, that is made from clay, that will actually influence the texture. I would argue, if your medium is clay, it will have an effect. But if it is glass, ceramic, if it is something else, paper cup, mostly it is not going to impact. So, Five of your students discussed, you say, for a T, medium has no influence.

Okay, use the word influence,

but it's also so A influences P. If the answer is yes, put out one. If the answer is not as here, right? It's that simple. Okay. What is here? In this case, A is medium. So you ask the question, does medium, does it influence? B? What is B here? Behavior. So you debate with your friends, right? Rationally, right? Will my teacup influence its taste?

So you can discuss, right? And [01:37:00] after you come to a , either you put down one or a zero. In this case, zero means. We did in class, most students said no, we put 0. Fine? Next. Does medium have an influence on itself? It's like self referential, it's 0, so put 0. Next. Does medium have an influence on the chemical structure?

So student, 4 students said yes. So don't put 4, right? Put 1, 4 should be 1 there. Got it? Next. Does medium, does it have an influence on the function? Function of t. Right. So, students said no. They have put zero. Next. Does medium, does it have an influence on how hot or cold it is? Yes. Right. The type of tea.

People said yes. So, instead of four again it should be one. Right. Four students said yes. So, like this, you go on asking this question. Right. Next. Does structure have an influence on the behavior? Majority. What is structure? Structure for a tea is? [01:38:00] The composition of how much sugar you put, how much milk you put, how much water you put, it has a huge bearing on the taste.

So, so they put two, two students. Yes. So that should be one, right? Anywhere you see numbers should be one, right? Five. So you can fill the whole chart, like this whole matrix you can fill. It'll take you maybe one hour after you sit and debate your problem. T is obvious. Your problem rate, if you go to waste manage.

Think about developing a piece of code, right? It's not, not being obvious. Right? You have to keep going back over and over again. Right? You fill the entire matrix. Now you have a matrix with ones and zeros. Right? You should have only ones and zeros. Now what you do? You add all the in degree, add all the out degree.

Right? And then, right? You add the in degree and out degree, this should be not 48 actually, why? Because if it is all 1, right, you will end up with 5 or 10 here, ok. So this, these will be, [01:39:00] numbers will be smaller, right, but it gives the general idea. So add both the in degree and out degree, you will have the total degree.

Now you sort it from the largest number to smallest number, which means your content comes up on top, right, and what comes up at the bottom, medium. So what this tells us is that you can also plot difference, right, out degree minus medium. The slide which I will update, I will correct this and update, you do not have to worry.

Okay, got this? Now, why did I do all these, uh, chacklary? A lot of, right, chuma putting 1s and 0s addition, right? We did not do any complex mathematics, we did some addition. Why did we do this? Why did we do this sorting? Why did we do this? Which has got the highest total degree, in other words, which has got a lot of influence and in turn it is influencing a lot of other things.

Not that it makes sense, right? What is the most important thing in a team? Somebody said taste, flavor, which means the powder itself is important that [01:40:00] that comes out right. Next. What is the next important thing? Purpose. Why are you having the team? So if I am IDC so bad, will I focus my energy? How can I make the best team on.

That is where I, my effort should be, you understand, or if I, if I put it in the form, how it looks, people do not care, at least the people who I call for this discussion was five guys, right. In their view, this is the thing. If I ask another team to do, you might get a slightly different result, you understand.

So without even doing this, you can actually say something is important, but this gives you a systematic semi mathematical approach of telling. Now should I focus my energy? If you're building a piece of software, which part of the, which is most important? Is the content of the software important? Or is it the process of software, the process of developing?

Is it important or is it the structure, right, you can do for your work, depending on the product statement you have at hand, this will keep changing. Got it. [01:41:00] Got this right? Yes. So I repeat once again, right? So you don't forget. So what we are going to do is if you want to innovate in your problem space. So, the fundamental question you can ask is where should I direct my energy, right?

If I am building anything, piece of software, application, product, product service system, whatever I am doing, right, I need to have some standard way of knowing where should I, some, it should point to me at least in the right direction, where should I focus my energy, right? Should I give focus on the form, function, right process, right purpose, I do not know, it is confusing.

Okay. 'cause I talk to different people. They're giving different, different, uh, things. So what I'm doing is I'm looking at an analytical way of studying the different contributing elements of the system, how they interact. That's what you're actually capturing. How do different parts of the system, when you talk about total, total degree, what are, we mean, [01:42:00] what are we doing in, in fact, we are looking at there are multiple parts of the system.

How do they interact? We has got the centrality somewhere, somewhere. I told you centrality, right. Which is, which is important, right. This fellow content is like influencing many things and it is also getting influenced by many things. So that is very central. So I am capturing that, right. So that gives you a little bit of analytical way of saying where should I focus my energy, right.

So when you start with, right, for purposes of discussion I put it as an argument. So for your problem statement, what is expected is you go back. Right, and you fine, right? I've given broad words, right? Behavior. What is behavior of your thing? What are you having here, right? The emergent behavior. Next thing is media structure, function form, so on and so forth.

If you have any doubts, you can always go back and refer to my previous letter examples I've given. If it's confusing, you can put their, and even then, if you're unsure, you can come and ask. Understood. Fine. Yes, sir. So once you do this, [01:43:00] you then look at the out degree. Right. And this is a group exercise.

You cannot do it alone. And it is observer dependent. If this guy does it, if I do it, there will be some, there is bound to be a difference. Right. I will say medium, yeah, cup has influence on the taste, I will say. He will say, no sir, ceramic cup. No, Right. So that, that difference will always be there. Okay.

That is why I said it is a semi mathematical approach. It is observer dependent. Right. So, you go element by element. You find out the in degree and out degree. You put ones and zeros. If there is a correlation, you say yes. If there is no correlation, you put a zero. Right. Once you do this, you count the total degrees, out degree and total in degree.

And you add up the in degree and out degree. Right. You have the total degree. Then you sort it in a, from largest to smallest. Right. In a descending fashion. Then, after you look at it, now you know the hierarchy, right? In the initial part of the lecture, I spoke about hierarchy. What hierarchy? Specifically, when I started with, right, where should I [01:44:00] innovating, right?

Where should I focus my energy, right? So, when you look at this, right, it tells me where to focus my energy. I should focus all my energy on the content purpose. Top three things, right, that ITC, if they are making, they should look at the context. Who are they making the tea for? More important, right? Are they making it for the video's sake?

So packaging, I will keep it different or am making it for some regular customer who wants price. Price, sensitive market, right? 50 rupees, I want maximum quantity, right? And also content. Content also matters. I cannot give some, right? Some garbage. I cannot target myself. So content really matters. And purpose.

What is this color using this T for, right? If you go buy a T packet in the us right? You get all these exotic things, right? One packet will. There'll be five little, I saw a package in five package. Like, what the hell? One package is 200 degrees. Who you spend? No, I would not spend. Right. But for them, right.

They have put right some, uh, oil where they extract [01:45:00] extracted from Alaya. Some story they have. Right? Nice Book it like a book. So for them it is a present, it's a Soviet. If I'm giving to a friend here, take this. It's from, uh, ASAM dancing is the best team in the world. Take it, right. He has got all these fancy pictures.

There is deal going right? All nature. There's a valley. Water is flowing right there. I'm focusing on the purpose. What is the point of this? It's actually being used as a gift. Okay? Then comes the context again. Who's my customer? Who's my demographic? Right? Then comes the function. Now function. I would've expected it to come at the first action if you ask me.

Now, process, I can ask the question. How do people typically make tea? Okay, process. How does this, uh, three roses make? He has got a powder packet. This one has got a powder packet. Now I can go back and then ask, okay, purpose, function. Like, if I take a broad view, right, then I can go [01:46:00] back and ask my customer, okay.

Let me look at, right, let me look at the process of making tea. Can I make it easier? Can I make it easier? Okay, so that's where you have the , right? Somebody thought, okay, this is too cumbersome. If I can just boil, and then somehow becomes idea, right? This is where, see beyond all this, right? This will give you some direction.

This will not give you the solution you tell. You have to focus your right because see, content, purpose, context function, right? I'm not able to do much there. 'cause already somebody's doing that, right? They're doing far better than what I can. So next step, okay, let me focus on process and tools, right? If I take that decision, if I go right, if I do that, then the question natural I'll ask is, okay, fine.

So typically how do people, how do they make boil and then becomes an headache. Can you do something to eliminate that pain? Now [01:47:00] you've got this something which you can us now comes another way. Okay? Typically, right? I'll give you another. Okay. I've got some pictures to show you. Can you,

can you see this guys? Listen, this is a like standard example, showed this, right? Keep these two right. My cabinet. So before [01:48:00] going here, right? Let's start with this. I am a manufacturer. Okay. So, what did, what did, uh, what did everybody say? Okay. Go to a public restroom. Would you touch a bar or so? Oh, no.

Somebody touched it. Maybe it's not COVID 19. Right? That was the scenario. Or maybe you got all these automatic faucets. You just show your hand, it starts spraying water. You're comfortable, right? You don't even have to touch the pipe. It flushes on its own. You just show your hand, it starts spraying water.

Right? So, non touch, non contact based. Pipes, which means stops still I have to use. Right? Or this guy has to use my swab. Maybe I'm covid, but even contract, right? So somebody looked at this and they asked the question process in our thing, right? If even if you look at T, right? Process came fourth or fifth.

Why the first three or four? I'm not even able to touch. [01:49:00] You gotta soap with fragrance. Yeah, I have. You've got anti I, an antiseptic soap. I have. You've got a colorful soap. I have. Let us start with this. So, you have soap that is bed sized, yeah. How do I touch it? How do I know it? Then I ask the question, behavior, purpose, function, right?

Then I say process. Okay. The process of you washing your hands, what are you actually doing? You need a soap foam, not the soap itself, you know. Somebody is thinking can I somehow turn this into a form where the user can take a small bit of the soap. Let us start this. Let's not go here. Let's start there.

If I can just give something right where I go and then it drops a cube, small soap cube, will it not be fine? Now I have to wash it. What happens? It takes some time to, for the thing to dissolve in water and gimme the frog to wash. As this is a starting point. Then you're asking, sir, it's much more co I add a little bit of glycerin.

I can turn the, so now let's [01:50:00] put at this. Now you're. That says, okay, you have one on the left. Ridge Protect. Now I've made a soap in liquid form. Nice. Right? I'm not touching the soap he's using, he's not touching. So every time I get fresh, right, even if I, if the surface is contaminated it, I'm going to wash my hands.

I'm fine. Right? Soap, I have soap on the left. Now Al is making Lifewise copied. Every fellow in the market has copied this. Then you ask the question, I want to eat it. Then what do you do? So, I can put some, uh, ayurveda, right, all the, uh, organic, right, all the fancy terms I can put. I can put carbon footprint.

I can argue all the things I want. Marketing. Actually, if I go, observe the process of somebody washing their hands. So, okay, taking soap, taking some water. It is actually thick. Liquid soap is thick. So, it actually takes a couple of seconds for that to dissolve. Then I ask the question, [01:51:00] ultimately what is the use of water?

Right? you have a shaving foam, right? Gillette shaving foam. Where is or no? My father days he used to have one tapa. He has to spin and that will give lather. Right? My day you get a tube. These days you get spray foams. When you shave a coat. Right? So similarly, somebody thought, okay, let me turn this to one which is on the right.

I have a foaming chofa. You If you press, you directly get full. What a beautiful idea. What a beautiful idea. How do you get this? See, I, what I am telling you is, I am putting you in the shoes of the designer who thought of that. Right? If you are, if you are destined to the idea, it's like, Okay, I have to write a piece of code.

Which means I have to learn every single algorithm in the world. This was the case. 1960s and 70s, if you are a grammer. You, you have to be the best guy actually. It's painful. Why? There are [01:52:00] no stack workflow. There are. There is no, what is GitHub stack workflow? GitHub. There is no GitHub. That's no repository, right?

How many of you actually code? I don't code. There is somebody better than me. All I do is just go copy paste Somebody has not better. A job of reading any code I want is done on the internet. I know that All I have to do is find the code and. Right? Or ask somebody in Stack Overflow, they will say, you stupid fellow.

This has been narrated 20 years back. Go and check this code. Right? Okay, fine. Okay? Somebody's code I am pulling, changing the variables, mapping it to my problem. Understood? How did this idea come? So somebody is like, sick of learning, right? Boss elimination, LU decomposition. Have you heard of these things?

Can you, how many of you can actually write a code for boss elimination? Raise your hand. Sir, I can actually write a code. That code for a generalized, [01:53:00] then you are not a programmer. You understand? These are some basic things. Please practice on this, okay? Go to this website.

How many of you know this website org? How many? It's a favorite website, right? For ERs, it's like a right? They've got a beautiful website, right? You can register for free. Payment is also not expensive. 5,000. It is not that good. You can even take a preview of the picture. Algorithm developer, I don't know any other place which teaches you better than MEA.

It taught me how to code, right? Right? I am a mechanical engineer by training, right? This taught me, right, many things, not only coding, right, Alien algebra, statistics, domain, anything to do with math, this website does a beautiful, about learning physics, right? You want to know AIML. Nice interactive animations there.

Check it out. How did this come to be? This product brilliant, [01:54:00] how did it come? It came because of people like me. This is too much math. I don't want to learn C I don't want to learn. I am a mechanical guy. I build things. I understand a little bit of control system. I want to integrate. Can you give me? I will tell you what I want.

I will give you A, B, C, D input. And you have to give me E, F, G, H as output. You do whatever you want inside and this is what I want. Right? And I don't want to keep going to a programmer. He is going to charge me. Thank you. Right. Can I have some standard algorithms? Right. That I can just download off the internet and put and use.

This is what you do. How many of you know how to program the microcontroller? 8085, do you have it? Is there in your syllabus? 8085? Are you sure? CSK is a, is a basic programming microcontroller. It will be there. Some microcontroller, just check it out. I don't know. Right. Distance I give to my computer, you have, I know.

But 8085, you are not on 8086. One micro control programming case, typically at least [01:55:00] days. Well, right. I check your service so all of you know. How do you know? Yes sir. Lance, how many of you can actually program on audio? Can you, what have you done with

running a what of motor? Easy motor. Okay, so you're saying right, it's easy, right? Actually plug, get a few wire and then you don't actually write what example? Not difficult, right? Configure the thing. You can write, you can write. It is not, not that difficult, right? Technically, you have to map a few pins, right?

Tell the PWM, right? Set the pin, go. Now if you do that, right, something like that, how did these things come out, right? And what I am trying to do, trying to get you to see is, right, how can somebody innovate, if I show you the product on the left, the Go Advanced protect, can, will you be able to take it to the next step?

And how do you take it to the next step? That is the challenge, right? Right, [01:56:00] because right if, can you improve a cell phone? Apple is struggling man. Right. They release a new, new one online. They're struggling, man. They're really struggling. Right? Nothing. They have just put one slide and then they, that's okay.

That's fine. Nothing practically 16 has got, they have nothing to offer. Right. They have run out of ideas.

I, I just, I just follow Apple, right, just to see the progress. Last five years, they are practically dead. I think next five years, they'll be done. Right? So, Samsung was doing a lot of innovation five years back. Now they have stopped copying Apple, right? And then they have actually stopped it. Right? They have, see, called their design team and blasted them.

What the hell are you doing? We used to experiment, right? Samsung put all these crazy ideas, right? Put a pulse oximeter on the phone. It a millimeter and IR blaster. You can use your Samsung, right? Apple went down the other way. This, right? So how do you innovate, right? When I show you something which is optimal, [01:57:00] most of the times there are based improve.

You can't see, it's not obvious, right? So the method, right, tells you that this in a systematic hierarchy, fashion, can you understand this going from here to here, right? These are the innovations we want you to. You may fail, but it is ok. Can you think of that, right? So, how did this guy come up with this foaming hand wash, right?

So, he is actually going, looking at a, right? Looking at a user and saying, ok, time, ok. And, oh, he is actually wasting some soap, right? Some soap you will get washed, washed on the washbasin, right? And he is wasting a lot of water, ok. Can I have a way to sanitize without soap? Somebody asked that question. Ok, I will sanitize.

Sanitizer. Sanitizer is a very recent thing. See, sanitizer, right, when I used to go to hospital back in 2000, right, there was one brand, Sterilium. Only doctors use Sterilium. That too, if they touch infectious patients, only then they use it. Okay, blue color [01:58:00] liquid, you have seen this Sterilium? That is the only sanitizer you, today you have got like flooded, after COVID, right, market is flooded with so many sanitizers, right?

But somebody asked the question, I don't have water, can I sanitize my hand without water? Somebody asked that question. Right? Then comes the solution. Then you go talk to a chemist, say, what is the bacteria, what is the virus, how can you kill it, you can radiate it, right? Somebody said, no, you can put it in isopropyl alcohol, that will rupture the cell membrane, that will kill bacteria.

If you want, just go to YouTube, Google isopropyl alcohol and bacteria. Literally, one second, bacteria will die. The moment it contacts the cell, the cell wall will rupture, they'll die. Right? It is that simple. Got it? So. Whole point of me showing you all this is right to just show you, right? If I give you a defacto stand look at water bottles, right?

Just look around you, right? So many different variations. Right Now there is one water bottle that I saw, right, [01:59:00] uh, last time, right? Prototyping, uh, we handled, uh, prototyping. So one guy came up with a timer for water. It'll ring every one hour, right? He put a water level sensor and then. Then, uh, recently I went to a call center.

They had a water bottle which literally had markings. 9pm, 8pm, 7pm, 5am. So when you look at it, if your water level doesn't correspond to the time, which means you are not drunk enough. What a simple idea. That's another argument. Okay. But the idea is, without spending one rupee extra, anyway I'm putting some marking on my bottle.

This tells me nothing. There it literally says 1pm. Now it's 4. 30pm. Five o'clock, there is a level and you're drunk and you're not drunk water. What does it tell you? You not drunk enough water just by looking at it. There is no battery, there is no sensor, there is no micro controller. There is no feedback loop, right?

You just look at it. That's a beautiful product. . Somebody thought of that, right? So [02:00:00] to innovate is not easy, right? But to innovate is also easy, right? You just have to take a different prospect. You just have to keep looking at evolution of softwares. How many of you actually. And then, see, look at the evolution of right?

Programming software. Right? Then we can try B C right? Badri, right? So, it can be named after him. Right? I had a friend called Deepak. He says, I will make like C, I will make D. That fellow was invested, I will make D. He is a crazy fellow. He is a, he is really a crackpot fellow. He told me once that, He said Karthik, he actually mastered C.

When I say mastered at a very good level, I'm talking 2002, 22. I mean almost 22 years, right? Basic fellow. What standard? This guy, like this big c, c plus plus, he has mastered any code on he will make. Okay? He said, I will. [02:01:00] I know s with see business, I'm going to improve, write my own thing. He didn't realize what it takes to build, right?

He didn't realize at. I met him some few months ago and said, how is your tea coming? He says, I can't. It's not a one man job. He actually then said, I've actually read a lot, I've spent a lot of time reading, I've come to the realization, right, C is optimal. Right, whoever made that, right, that's like a really optimistic thing.

It's very difficult to come up with anything like that. Python does a few things better, right, in terms of integration, right, but in some ways C is still the king. That is what I was talking about, right. You start with Z, right. So, point is to just look at this problem, right, from this, from in fact, hex code, not even basic, from hex code, from in fact machine code.

I told you in Apollo 11, how were they programming? 0 and 1. I [02:02:00] told you, right, every magnetic ring they have to magnetize and demagnetize. Imagine somebody messing up 1 0 or mess up your Right, you have to have parity correction, error correction mechanisms, right? For me the best, you know who are the best programmers?

Any idea? It's the guy who wrote the code for Mario. Mario Bros. Why? You have a 8 KB cartridge, right? 8 KB cartridge. You have to have the background graphics, character that moves, game engine, right? Right. All the physics, game physics, and then music. This in 8KB and there are no over there update. If he messes up, Nintendo sold like, I think 50 copies of game.

So, I think, so I don't think it's one guy, right. Okay, team of programmers, right. They did that. Right. Now what is the prevailing attitude, Microsoft, they are writing? Next OS [02:03:00] update we will see, man. Clock is broken up. We will put an update, right. This luxury they did not have, right? If I mess up that cartridge, right, they'll make not 1 million, 50 million copies, 50.

Even then there are box value people exploiting. There's something called speed running. Just go to YouTube and then for speed run, bring some of you people still exploit those box to just weekly walk, write no, go through certain obstacles, right? I dunno how they find those. Right? They'll be playing like ance, right?

So they, they even hold world records. Like one minute I. Let us take a look at the, no the point is, point is, if you have to program, Luigi and Mario share the same body, they swap the head. Change the shirt, Sprites they have something called Sprites, right, they will change part of the textures, that is why they are able to save even in bytes, so you as the programmer have to understand, right?

The reason I asked you, do you really understand 8 stroke, right? So you do not have to, right? So you get a game file that comes out like a 100 GB, 150 GB some games, crazy [02:04:00] size, You My day you get one DVD, maximum 4 GB, or maybe you got 2 discs, 9 GB, that's it. Like even the biggest games, right? So, some, just have a game, functional game that is, that is like in kilobytes, like a couple of kilobytes, right?

Population is low with a huge age population who are retired. Right? China is heading for this. Japan is already here. South Korea is already here. Singapore is already here. US is here. We are transitioning from this to this. Our window of opportunity will close by 2040. What year is this? 2024. Another 16 to 17 years.

Our pyramid will do this. Okay. As our population with funds. Right. What happens? You will be paying my pension. You guys will be paying my pension. I am paying, right, my father's pension. My grandfather's pension. You will be paying my pension. Who will pay your pension? [02:05:00] Right? Next generation. How many of you are going to be there?

Who will pay their pension? These poor folks here. There are thousand people here. There are hundred people here. They have to work like crazy to compensate, understand? So, every nation has to go through this cycle, this photographic cycle. But this also presents a, not an opportunity. What is the opportunity?

I'll give you a big secret, right? Which is out in the open, most people don't realize it. I'll give you a big secret. Sir, I don't have employment, sir. What do I do? No problem. Look at this pyramid. Do whatever you want. You do whatever you want. Right? This is the old people. They are going to grow. When old people grow So, anything you do, that links to problem solving of old people, there is a risk of shortage.

I repeat, anything you do, that can actually help some old, old age person. Because why? There are going to be, [02:06:00] once I retire, what? I will have knee problem,

right? I assistive devices, right? All this I need. My vision has gone bad. Any spectacles? Medicines you understand, my expenditure towards my health will actually increase. So if you are one is linked to that, then your work is safe. You understand? If you're just thinking short term, okay, let me find a job.

No, no. Do what a computer cannot do. Fails to do. Do what? Fail to do in 10 years. That's difficult. That is difficult to predict. But one thing I can tell you is Chad J. Petty, hopefully, does not still understand context 5 years down the line, 10 years down the line. He still does not understand context, right?

Right? There is a, uh, famous designer called on YouTube. That guy, he showed 10, 000 designs for a show in 2 minutes, [02:07:00] right? This dolly he is able to generate and give. But he does not understand context. Half of the design he produces are useless. No value. It is just mixing up and then giving something.

Understood? Right. Stop the lecture here. Right. So, today we complete. This is the reference. Slowly we will move to the next. I will post the assignment. Right. All the instructions. I will post it there. Please submit the assignments on time. Right. Okay.