H05 Class 2

**Agenda:**  
Agenda for Coaching Session (with Timing)  
  
Opening & Check-In (5 minutes):  
  
Brief discussion on how the coachee is doing and current challenges.  
  
  
Goal Review (10 minutes):  
  
Discuss progress on previously set goals and evaluate.  
  
  
New Learnings & Feedback (10 minutes):  
  
Provide insights, suggestions, and feedback for improvement.  
  
  
Action Plan Development (10 minutes):  
  
Create a clear, actionable plan for the coachee’s development.  
  
  
Wrap-Up & Support (5 minutes):  
  
Confirm next steps and what support is needed.  
  
  
  
Total Duration: 40 minutes

# Transcript

**Speaker\_03 - 00:00**She will become  
 **Speaker\_01 - 00:09**the  
 **Unknown speaker - 00:19**professor.  
 **Speaker\_04 - 00:28**No  
 **Unknown speaker - 00:46**one.  
 **Speaker\_00 - 00:46**So we will be circulating these three sheets for block.  
So we will be circulating these three sheets for one of the block.  
We have to write your name and roll number.  
After you give, we will be counting from each batch how many are there.  
and it should match with the number of names.  
So we will be covering the remaining part of the syllabus that was not covered in the first class.  
In today's class to the extent possible and if there is some part that is left, it will be covered in the Saturday's class.  
 **Speaker\_00 - 02:01**So I give you 5 minutes of time.  
Like the first picture might be very common to you all, the first picture.  
The second picture, some of you might be knowing it.  
I will give you five minutes of time.  
You need to observe that.  
You know that this is the picture of evolution.  
But what I want you to write, you just take a paper and write down.  
 **Speaker\_00 - 02:31**In five minutes, why this happened?  
Why this happened?  
Say if there is seven stages of human evolution.  
Why that happened?  
Why do you think it happened?  
You just observe it from the left to right, you just observe it and what are the changes that you see and why it happened?  
I want you to think and write about it.  
 **Speaker\_00 - 03:01**Take 5 to 10 minutes of time and just observe it and write down.  
The picture is very common to you, but I want you to write why it happened like that.  
For example, I will give you one clue for example.  
A bike is more stable system or a car is more stable system.  
Why?  
It is on four wheels, bike is on two wheels.  
If that is the case, On the top picture, the leftmost is the stable way of walking or the rightmost is the stable way of walking.  
 **Speaker\_00 - 03:48**Which is a more stable way of walking?  
On four legs or on two legs?  
Four legs.  
So if something is evolving, it has to be for some betterment.  
If you say that four legs, walking on four legs is better than walking on two legs, then why it evolved like that?  
For example, I am just posing one question.  
in similar fashion you just observe it and write down what do you what do you feel about it and why it happened  
 **Speaker\_03 - 04:35**like that.  
 **Speaker\_02 - 04:46**what?  
 **Speaker\_03 - 04:50**This time I think it's  
50 or something.  
 **Speaker\_04 - 05:05**The paper is, what is the paper is?  
 **Multiple speakers - 05:14**My question is clear to all  
 **Speaker\_04 - 05:32**of them right.  
Okay.  
 **Speaker\_00 - 06:45**I will ask one more question, which is more energy efficient, walking on four legs or walking on two legs?  
Stability is more by walking on four legs, but energy efficiency is more by walking on two legs.  
So you are losing something and you are gaining something.  
And say if you are walking on four legs, all your four legs are used only for the sake of walking.  
If you are walking on two of your hands will be free to do any other task.  
So which system is better if you want to do multitasking?  
So you are compromising stability for energy efficiency and doing multitasking.  
 **Speaker\_00 - 07:37**And what is the advantage of doing multitasking?  
Generally  
why do you want to do some task?  
Generally why people work?  
How the economy grows?  
Why the economy grows first of all?  
Why the economy grows?  
 **Speaker\_00 - 08:01**Or why the society always seeks for some development?  
 **Speaker\_03 - 08:05**Survival.  
End goal is survival.  
 **Speaker\_00 - 08:08**One is survival.  
Other than survival?  
Quality of life.  
If you want certain level of quality of life, somebody else's contribution is there and everybody is working towards some part so that ultimately it's your survival, it's your greed or it's your wish or it's your will.  
These things are the driving forces for all of you to work.  
And if you have to work.  
you try to work in an optimal way so that you earn more and the moment you want to work in an optimal way you have to use your body optimally if you want to use your body optimally you have to use your resources optimally if you want to use your resources optimally that is one of the reason you  
 **Speaker\_00 - 08:52**moved from by walking from four legs to two legs because you want to use your body optimally the moment you say optimally You just try to segregate resources so that you'll reach some end goal.  
I don't want to use all the four legs to just to walk.  
I'll use two to walk and two of them I'll use to do some other work.  
So you are trying to optimize your own body resources to achieve some end goal of yourself because there is an ultimate goal of society.  
Everyone in the society that everybody want a better life tomorrow compared to today and for that everybody has to work.  
So from the left extreme to the right extreme, what things changed?  
As time passed what things changed?  
 **Speaker\_00 - 09:40**Quality of life and what other things changed?  
 **Speaker\_03 - 09:44**Environment.  
 **Speaker\_00 - 09:46**For example, what was the environment in which leftmost extreme species was there and what is the environment in which rightmost species is there.  
Yeah.  
Leftmost was in forest, for example.  
And rightmost is in?  
So the environment changed from a forest to say one city.  
And if you take a forest, if you take a forest,  
for example, if some animal is chasing you.  
 **Speaker\_00 - 10:25**and you are running if some animal is changing and you are running you want the run to be more stable or less stable then you go for four leg or two leg four leg but is that problem there in city in Chennai will animal run back of you but in the forest you have to save yourself so the environmental  
conditions changed with respect to time the conditions in which you are living in which maybe you are living in a more safer place in the right extreme so you don't want that much stability anymore.  
So the environment is changing with respect to time and based on that because environment is changing what is happening to your own body?  
So these what kind of intelligence?  
So you are adapting.  
You are adapting based on the change.  
The below picture is also somewhat similar.  
 **Speaker\_00 - 11:34**You can go to the next slide.  
So you can read the content whichever is there in the slide, maybe after the class.  
But there are two words that are highlighted in the red color in the second paragraph.  
What are those two words?  
Self-evolve and self-improve.  
Can you correlate these two words with the picture whichever I have shown in the previous slide?  
Was the human self-evolving?  
 **Speaker\_00 - 12:05**Was he self-improving?  
The word improve again tells with respect to what?  
You cannot tell that stability improve.  
Overall goal or overall efficiency improved.  
Not stability didn't improve there.  
So your goals are getting improved.  
I am using the word goal, not the word stability for example.  
 **Speaker\_00 - 12:26**Now can you tell the definition of intelligence?  
In varied environments.  
 **Speaker\_03 - 12:35**To achieve a goal.  
 **Speaker\_00 - 12:36**To achieve a goal.  
Here the goal is not to improve the stability.  
The goal is to be stable.  
You have certain level of stability but at the same time do some other task so that you will be able to do more work and you will be able to contribute more or you will be able to earn more so that the society recognizes you or you can you will be able to earn more and in overall society there will  
be a development so that is the end goal you each of you are contributing to certain level of end goal ultimately there should be some development and there should be better way of life so that is the end goal so it should self evolve or self improve from the interactions from environment So as I  
told with respect to time, environments were changing based on the environment you are adapting that's why it is called as self evolve or self improve.  
So any word or any terminology that you come across before reading the definition if you see some picture and try to understand what it is it will be easy for you to follow later.  
 **Speaker\_00 - 13:44**So the second paragraph the third paragraph over here starts talking about artificial intelligence, for example.  
How can you correlate artificial intelligence with self evolve and self improve?  
So, in order to achieve a final goal, For example, humans started self-evolving and self-improving.  
They improved themselves in order to reach a final goal.  
The same idea or the same things if you try to do artificially, you can name it as an artificial intelligence for example.  
That is what is mentioned there.  
We will go to the next slides where you might understand the things better.  
 **Speaker\_00 - 14:47**Now I'll give you three to four minutes or five minutes.  
There are four questions over here.  
There are four questions.  
Read those questions and try to answer in one sentence in that paper with respect to the idea that you selected.  
Like there are 16 batches and you selected so many ideas, right?  
If you take one particular idea from whichever you shortlisted, Take that idea and try to answer this four questions for that.  
Take a paper and try to answer that.  
 **Speaker\_00 - 15:26**I am asking you to write it down so that it will be more clear for you.  
Answer that four questions.  
How to design basic system components in which decisions are distributed and not fully controlled by a single component.  
Try to attempt all the four questions.  
What  
is the meaning of the first question?  
 **Speaker\_01 - 17:13**Sir, let's say for example, there are voluntary and involuntary movements.  
So, if I want to pick up this object, then there is this entity brain.  
So, brain tells pick up and I'm picking up.  
But let's say for example, I'm touching a heart object.  
So, my reflex actions say that I have to immediately take my hand off.  
which is taken care by spinal cord.  
So in different context your distance should be taken in different ways.  
 **Multiple speakers - 17:55**So that is what he told.  
 **Speaker\_00 - 17:58**So is it clear what he told?  
Like all the actions of your body can be controlled by either single entity or it can be distributed.  
Like that is what he told.  
He told involuntary actions and voluntary actions, for example, one is taken care of by one entity, one is taken care of by one entity.  
For example, if you touch a hot object, will the brain take the action?  
So, it's not controlled by brain.  
Whereas, whether to come to this class or not, the dash is taken by your brain.  
 **Speaker\_00 - 18:33**So, all the activities shouldn't be depend on one entity.  
That's what the first question is.  
We will see for what purpose it is.  
What is a disadvantage of having only one entity controlling everything?  
If it fails the whole system fails that is one major disadvantage.  
So now for your own idea try to answer it like for example whether you need two control units or whether you need three control units for the sake of you can pick any one of the idea that you generated and just think like what are the tasks it is supposed to do and what tasks whether I need two  
control needs or three, whether which one is the main one and how should be the loop so that it will be more stable or it will be more safe.  
 **Speaker\_00 - 19:33**What is the meaning of second question?  
What is macro level and what is micro level?  
For example, if I am moving on this steps, what is the macro level decision?  
Where is the macro level decision that is happening?  
In my brain maybe it is happening that I am stepping down.  
That is a macro level decision.  
But if I am doing this task, there are so many sub parts in my body, different cells, bone movements, everything is there.  
 **Speaker\_00 - 20:10**And there are several micro level decisions that are happening at each and every stage.  
I am giving an analogy of human being but in your system what will be the macro level decision what will be the micro level decision and which controller will take care of macro level decision and which controller will take care of micro level decision and how they both will be interacting which is  
a better strategy for your product that you are developing what is the meaning of third question  
Second thing is the design strategy, third thing is the rules.  
Second thing is how should be the components be controlled, where the controller should be.  
Third thing is what to do with that controller.  
For this event, what to do.  
 **Speaker\_00 - 21:09**For this event, what to do.  
For event one, what should my micro level controller should do?  
What should my macro level controller should do?  
for event to what should be micro level controller should do, what should be macro level controller should do.  
What should be, what it should do is the third question.  
How it should be, what should be the architecture of the system is the second question.  
First question is that it should be decentralized, second question is that in what way it should be decentralized, how many controllers will be needed.  
 **Speaker\_00 - 21:40**Third question is for different events, what should be the decisions taken by different controller?  
That is the third question.  
What is the fourth question?  
Once you develop this system, you are supposed to test it.  
That is what is the fourth question.  
Can anyone of you tell some idea that you generated for your group?  
 **Speaker\_03 - 22:17**Anyone?  
 **Speaker\_00 - 22:26**One idea if I can remember is protecting from fall.  
Having a device to protect yourself from fall.  
So if you have a certain device, the first question says that how you are going to decentralize the intelligence within this system.  
The second question asks, what are the micro level decisions and what are the macro level decisions?  
Third question, what are all the different possible situations and for different possible situations, what are the decisions first controller will take, what are the decisions second controller will take?  
Fourth question, what technology that you have so that you will test the developed technology so that it is very efficient enough?  
Feedback loops.  
 **Speaker\_00 - 23:26**There are four words over there.  
Monitor, analyze, plan, execute.  
Monitor, analyze, plan, execute.  
What is happening from left to right?  
What is the meaning of monitor?  
 **Speaker\_01 - 23:48**See what changes are happening?  
Observe.  
 **Speaker\_00 - 23:52**Monitor is the initial most part.  
For example, you can correlate with your eyes.  
If you are seeing something with your eyes, you can call it as say monitoring or seeing.  
After seeing the information goes to your brain.  
What happens in your brain?  
You analyze.  
After you analyze what you do?  
 **Speaker\_03 - 24:16**Take decision.  
 **Speaker\_00 - 24:16**Then you take some plan.  
And after the plan forms in your brain, what you do?  
Execute.  
These at a very higher level.  
These at a very higher level.  
By the time, for example, if I take the same task of me seeing these steps and walking, stepping up or stepping down, I am seeing, I am monitoring the steps, I am just planning how much depth it is there, I am analyzing the depth, I am planning how much I need to, at what length I need to move the  
leg, then I am executing.  
 **Speaker\_00 - 24:52**Finally, I am executing.  
These are at a very high level.  
So, this is called as M-A-P-E, monitor, analyze, plan and execute.  
So, I am a smart system.  
I am doing this monitor, analyze, plan, execute.  
These are at a very high level.  
But where these loops will come into picture.  
 **Speaker\_00 - 25:14**For example, if I see this step.  
If I see this step and if I want to get down this step, is it a single time feedback that I get or is it a continuous feedback that I keep getting?  
The moment I am trying to keep my step from here to here, every time the signal keeps going to my mind that, okay, how much amount is left, how much amount of force I should reduce, how much amount of force I should increase.  
So everything keeps running in continuous loop.  
And sometimes it says, okay, you are going right.  
Sometimes it says you are going wrong.  
The moment it says you are going right, it's positive feedback.  
 **Speaker\_00 - 25:57**The moment it says you are going wrong, it's negative feedback.  
But what is the ultimate aim of having these feedbacks, positive feedback and negative feedback?  
There is a chance that I might fall down here.  
So, it means that I became unstable.  
If I want to execute some task in a stable way, I need both kind of feedbacks.  
I need positive feedback and negative feedback.  
Positive feedback says that the direction you're going is correct, keep continuing.  
 **Speaker\_00 - 26:31**Negative feedback says the direction you're going is wrong, don't go in that direction.  
And these two feedbacks occur at micro level and the macro level at every stage of the device.  
The same thing you can correlate with that fall protection body.  
Try to correlate it with the fall protection body.  
Is there any feedback needed there?  
Say there is a human, he is falling.  
Just like I am stepping up, a human is there and he is falling.  
 **Speaker\_00 - 27:06**And your device is there.  
How your feedback helps there?  
Say you have fault detection sensors and there are some proximity sensors for example and the proximity sensor is continuously telling while you are falling you are getting a continuous feedback like what is the distance that is left between you and the floor it is giving you a continuous feedback  
based on that your controller should take some decision and you have multiple proximity sensors for example and the data from multiple sensors will be coming all our feedbacks that actually tells in which orientation you are falling.  
And where should be my balloon or some other protection mechanism should pop up.  
If you are falling on this side, you should focus more on this side.  
If you are falling on this side, how will you get that information from the sensors that are placed?  
 **Speaker\_00 - 27:59**And those sensors are giving you the feedback.  
And some sensors, the feedback that is given, it might become a positive feedback from some sensors it might become a negative feedback based on the orientation you are falling.  
For example, if I am falling on this side, these sensors says that you are not falling on this side, you are falling on this side.  
If you are falling on this side, so the feedback from one sensor will become positive, the feedback from some sensors will become negative.  
Next one.  
That is what is there is there in this slide.  
So you need both positive feedback and negative feedback in order to be stable and achieve the final goal.  
 **Speaker\_00 - 28:46**Next slide.  
So these are some biological examples where you can see the positive feedback and negative feedback.  
So have you heard of van its systems in your vehicles?  
Those are called vehicular ad hoc networks.  
So when you have a car and you are driving a car on the road, if the multiple cars are equipped with van its system, they actually communicate among the cars and they also communicate to the central if you're going on a particular lane at some speed, your car talks to the neighboring car telling  
that I am going with so and so speed and they communicate with each other so that you can avoid collision.  
Similarly, they can also communicate like I am in this place and so many cars are stuck up here, so don't take this path, take some other path.  
 **Speaker\_00 - 29:57**So the communication among these cars for the sake of either for the sake of safety to avoid some collision or they even communicate with even the side lane path.  
There are some device that are fixed on the path and the car can communicate with it, not just among the cars.  
Everything is for the sake of safety, either for the safety or to achieve the goal faster.  
Like you want to avoid the traffic or you want to avoid any jam.  
You have this vanit architecture that is there and that is actually inspired from your bees.  
That's what is there in this slide.  
And what kind of intelligence it is?  
 **Speaker\_03 - 30:45**Cooperative.  
 **Speaker\_00 - 30:46**It comes under what kind of intelligence?  
 **Speaker\_03 - 30:49**Cooperative.  
 **Speaker\_00 - 30:55**So there are four kinds of AI techniques that are listed.  
For example, if I ask you to make an IRCTC portal.  
If I ask you to develop an IRCTC portal, what technique you will use out of that four?  
One thing is one thing is rule based, one thing is fuzzy logic, one thing is artificial neural networks and one thing is evolutionary computation.  
If I ask you to make an IRCTC portal out of that four, what will you select?  
The current IRCTC portal, whichever is there.  
Which one you will select out of that four?  
 **Speaker\_00 - 31:40**First one.  
Will you go for rule based or will you go for fuzzy logic?  
Like you all used IRCTC portal to book the tickets.  
Since you used it you know how it works right.  
For example, rule based.  
When something can be called as a rule based.  
If you are so sure that component X is this, component Y is this, component Z is this, if component X and Y are like this and if Z is like this make K. You are so precise that this is this, this is this, this is this and if these are like this do this.  
 **Speaker\_00 - 32:24**You are so sure that these are fixed and it happens in that way only.  
That is called as a rule based system.  
Whereas if you bring some level of uncertainty, then you cannot go for rule-based system.  
For example, if I ask you to develop an air conditioning system, AC or a washing machine, if I ask you to develop that, and if I ask you to write logic for an air conditioning system or a washing machine, where things are not perfectly rule-based, for example, an AC has to work based on the feedback  
from the temperature sensor of the room and it is supposed to maintain the room at some temperature and you cannot write rule like if my room temperature is 23.7 degree do this if my room temperature is 23.8 degree do this there you have some level of uncertainty where the temperature is a  
continuous variable where it can be temperature can be 23.731 28.736 So you don't have a very definite input.  
You only have some range of inputs and which are very uncertain in nature.  
 **Speaker\_00 - 33:36**There you take decisions based on the uncertainty to some level of uncertainty, but with some human intervention.  
For example, if the temperature is somewhere between 22 to 23, if the room temperature is then switch it off.  
If the user has said 22, if it is somewhere between 21.7 to 22.3, you switch it off, you maintain it.  
You cannot always say that user has set 22 and that sensor reading is 22, now you switch it off.  
Immediate next moment what will happen?  
The temperature will drop down to 21.99. Then it will switch off.  
Again it will switch off.  
 **Speaker\_00 - 34:15**Again it will switch off.  
You understood what I'm saying, right?  
So user has set something in the real time.  
I want 22 degrees.  
And if it goes below 22, switch it off.  
So even if it becomes 21.9, it will switch it off.  
Whereas if you give some range for example, so if the room temperature, whatever you are measuring, if it is somewhere between 21.5 to 22.5, you switch it off.  
 **Speaker\_00 - 34:41**So user has said 22. If the room temperature is anywhere between 21.5 to 22.5, in that range it will be off.  
Only if it goes above that it will switch it on.  
If it is going below, it will either you have to have some heater or something.  
So here where you don't have definite inputs, where the measured variables will be uncertain, you need to go for fuzzy system.  
So, one difference between rule based and fuzzy system is in a rule based, for example, in IRCTC portal, you can tell that whether you are male or female or some other gender, you will be selecting one and that is perfectly correct.  
Not like temperature, there is some variable.  
Here you know very precisely that is that.  
 **Speaker\_00 - 35:27**and whether you want lower birth or upper birth or middle birth, it's fixed.  
So based on the final outcome, you can trace back what were the inputs to the system.  
So finally the ticket was generated, the person age is this much, and the person selected for so and so birth, and person selected from here to here.  
So you know all the inputs that the user give to achieve at some final outcome, very precisely.  
So out of that four methods, First method is the only method where you will be able to trace back the input.  
But in the same case, you take 10 air conditioning systems in 10 of your homes.  
If the AC is and in all the 10 homes, you set the temperature to 22 degree centigrade.  
 **Speaker\_00 - 36:07**And the AC was off in all the 10 homes.  
There is no guarantee that the actual room temperature was 22 only in all the 10 homes.  
Because you are trying to deal with uncertainty there.  
So, but in fuzzy systems there is uncertainty.  
But there is a human intervention to it.  
So if the range is this much to this much, do this task.  
If the range is this much to this much, do this task.  
 **Speaker\_00 - 36:33**If the range is this much, this much, do this task.  
So it can be anywhere in that range, but the task will be executed.  
That is a fuzzy system.  
When you go to artificial neural network, you don't even know what range to set I don't know what should I do at least in the second case I know what should I do in those ranges in the third case I don't even know what are those ranges so I will I will just create a network architecture and I will  
train it and I will ask it only to decide what it has to do so first case I know very precisely what it is and what it should be done in the second case I know what to do but I don't know very precisely in what ranges it should do that way.  
In the third case I know finally what I want but I don't know what to do or how to do.  
The only thing that I know is I can make some architecture and I can train it so that it will only decide what to do when to do.  
 **Speaker\_00 - 37:30**So that is a difference between first case, second case and third case.  
Okay, let us take the third case.  
Let us take the third case.  
Artificial, like any one of you, all are you are all are you are from computer science background, right?  
Anyone to any basic course on machine learning or AI till now?  
Is the any course was there till now?  
Okay.  
 **Speaker\_00 - 38:04**At least have you seen such architecture before?  
Have you seen such architecture before?  
The architecture of a neural network.  
I am talking about this.  
Have you seen this architecture before?  
 **Multiple speakers - 38:30**Yes sir.  
 **Speaker\_00 - 38:34**So do you know how to interpret this?  
Do you know how to interpret this?  
What are the four words that you can read over there?  
Input layer, hidden layer 2, hidden layer 2 and some output layer.  
The input layer actually takes the input from the user or input from some other module and it has to do some activity and it has to give some output.  
Input can be of any type.  
For example, say input is a Boolean logic, for example.  
 **Speaker\_00 - 39:31**Say input is Boolean logic.  
So if there are four inputs with Boolean multi-valued logic, each input can take five possibilities.  
Each line can take five possibilities.  
There are four such inputs.  
Then?  
So these are the inputs.  
So instead of four, I'll make 400. Instead of four inputs, I'll make 400 inputs.  
 **Speaker\_00 - 40:02**Each input can take 100 possibilities.  
400 inputs are there.  
Each input can take hundred possibilities.  
Total how many possibilities of inputs will be there?  
What will be the value of it?  
What will be the approximate value of it?  
Okay, those are the number of inputs.  
 **Speaker\_00 - 40:42**In output what is there?  
In output what is there?  
There are two right.  
Again the two can be either Boolean.  
If it is Boolean how many outputs are possible?  
Again, the same computation, if it is different level of outputs if you can take.  
So, let us take simple example of say stock market prediction.  
 **Speaker\_00 - 41:13**Whether I want to invest more or whether I want to take away the money or whether I want to retain like that.  
Three possibilities.  
Take output to be boolean.  
So, four cases are possible.  
Zero-zero case, let us assume I will not use.  
Zero-one case.  
I will invest more money, one zero case I will take back the money, one case I will leave it like that.  
 **Speaker\_00 - 41:39**So there are three possibilities that the neural network is giving whether it is telling me to invest more or take back the money or leave it like that.  
So three possibilities at the output.  
Input is what all parameters will impact the stock market?  
Current market value, what are all things that will impact stock market for example?  
There are numerous things that will impact stock market.  
There are numerous things that will impact stock market.  
Can you name few of them, at least four of them, three or four of them?  
 **Speaker\_00 - 42:21**Or shall I change the example to some other example instead of stock market?  
 **Speaker\_03 - 42:26**News.  
 **Speaker\_00 - 42:30**Okay, I will make it even simpler.  
Say  
whether I want to purchase a car or whether I don't want to purchase a car or whether I want to keep the same car which I am having.  
It is depend, it depends on what all activities.  
Price of the new car, your income level, condition of the existing car.  
There are so many conditions.  
Why to the example of stock market is there are numerous factors that are going to impact the stock market.  
 **Speaker\_00 - 43:12**In the second example, whichever I gave, it's very easy for you to realize, okay, this much amount I have, this is the car I have, whether I should change the car or not.  
You can easily take a decision there.  
Based on the inputs, you will be taking some output.  
But with respect to stock market, for example, or it can also be, say, weather prediction, whether tomorrow, whether there will be rainfall or not.  
say yes or no, whether rainfall will be there or not, is also dependent on so many complex parameters.  
The existing weather conditions, the weather conditions which are there in the surrounding places, so many parameters will be there which will act as an input and so much of information is there based on which you are supposed to take a decision.  
But what we don't know is, first thing sometimes we don't know what all parameters will affect.  
 **Speaker\_00 - 44:06**Second thing what we don't know is if a parameter will affect, to what extent it will affect.  
First point we don't know many times is what all parameters will affect.  
Second thing that we don't know is if a parameter impacts to what extent it will affect.  
So here in that network what you are trying to do is you are taking all permutations and combinations of something.  
If you see all that zigzag lines over there, you are taking some inputs and you are trying to compute all permutations and combinations and you are trying to give weightage for it.  
Whether it's a more important event or whether it's a less important event, whether it will really impact your thing or whether it will not impact your thing.  
You are trying to get all permutations and combinations.  
 **Speaker\_00 - 44:57**Reason is you are not sure of what will impact in what In the first case and second case, you know very well what will impact you and in what way it will impact you.  
In the third case, you don't know what all will impact you.  
That's why you take all the possibilities that are there.  
And how do you get all the possibilities?  
Based on some parameters, you take all the combinations and permutations so that you will get all the possibilities.  
And you try to, when you train the model, the weights, when the weights they are getting updated, what the weight is doing is it is telling to what extent that you will be impacting your output.  
If the weight is 0.1, it will impact less.  
 **Speaker\_00 - 45:38**If the weight is 0.9, it will impact more.  
If the weights are between 0 and 1. So you are trying to compute those weights in the network.  
In each and every node, you are taking all permutations and combinations and you are computing the weights.  
And as you are training it, the weights will update and the weight value at each node tells whether that thing is going to impact you more or less.  
I will take one more example, say image recognition, face recognition.  
If you want to make an attendance management system by taking a picture of a face, so what all parameters will be there for input, for example, if you take a face, if you take a picture of a face, what all parameters are there in the face?  
One thing can be dimensions.  
 **Speaker\_00 - 46:32**Nose length, distance between the eyes, circumference of the face, the color of the skin.  
Take four parameters.  
First parameter you can take length of the nose.  
Second parameter you can take distance between the eyes.  
Third parameter you can take the total circumference of the face.  
Fourth parameter you can take say color for example.  
Out of all the class who are there.  
 **Speaker\_00 - 47:01**If I circulate a sheet now and if I ask you to measure the length of your nose, distance between your eyes and say color like I will give you four scales in the four scales in what scale you keep yourself.  
If I circulate the data among you, if I circulate the data among you, one thing is length of the nose, one thing is distance between the eyes, One thing is the surface area of the face and fourth thing is the color.  
Those are the four inputs to my model.  
And based on this, I want to make a detection system.  
For example, the length between the eyes, if I take that parameter, there are 160 of you.  
There are 160 of you.  
If I only want to segregate you all based on the length of the eye, will it be feasible?  
 **Speaker\_00 - 47:53**Or will the system gets confused?  
my system if I take only one parameter the length between the two eyeballs is the only parameter that I am going to take to differentiate between two people.  
Is it feasible?  
It may or may not be feasible.  
But if I add one more parameter of the length, so the distance between the eye is this much and the length of the nose is this much.  
Why I am telling is.  
Here you are taking, the first one you are taking is the length between the eyes.  
 **Speaker\_00 - 48:31**The second thing that you are taking is the length of the nose.  
And in the second stage what is happening is it is taking all permutations and combinations.  
So the eye distance is this much, length of the nose is this much, and the surface area is this much, and the color is this.  
For every input, for every person, for every person there are four parameters.  
and all the four parameters are passed into the model and it is taking all permutations so that the system won't get confused.  
So if you again come back to the system when it takes the picture of you it will get your eye length, nose length, color and the face area.  
It is already trained and it won't get confused because it already took the permutations and combinations and for example the model already know that in the class I can segregate eye length into eye length into say three categories.  
 **Speaker\_00 - 49:29**One category above this much, one category below this much, one category below this much.  
So the moment you come back, the moment it measures the eye length, it will rule out that you are not one among that 160, you are only one among 80. The moment it sees nose length, you are only one among 30. The moment it sees area, you are only one among 10. Then finally when it sees the color, you  
are the person.  
So from a broad from a broad population, it wants to rule out.  
If it wants to rule out, it needs more information and it shouldn't get confused.  
So you have, it has all the data, four parameters per person, and it took all permutations and combination, and when you again come back, it actually rules out.  
And it finally detects that it is you.  
 **Speaker\_00 - 50:16**So this is nothing but it is taking data, and it is taking all permutations and combinations, and for every combination it is taking a weightage.  
What that weightage tells is this.  
The model will clearly know that in a class there is no one with this much length eyes and this much length knows with this much color.  
The probability is very low.  
Such kind of person doesn't exist in this class.  
The model knows because the weights.  
Each weight over there actually tells.  
 **Speaker\_00 - 50:46**Let us go back to the fourth one.  
Fourth one is evolutionary computation.  
What is the difference between the third one and the fourth one?  
ANN and artificial neural network and evolutionary computation.  
What is the difference between them?  
Artificial neural network is inspired from what?  
 **Speaker\_03 - 51:13**Human neural networks.  
 **Speaker\_00 - 51:15**Artificial neural network is inspired from human brain.  
What is the fourth one inspired from?  
Fourth one is inspired from the evolution.  
What is the difference between the third one and fourth one?  
The thing where it is inspired from is different.  
Third one is inspired from the human brain.  
How the neurons will function, how the human brain functions.  
 **Speaker\_00 - 51:40**The fourth one is inspired from how the species evolved.  
What is the statement of evolution?  
Survival of the fittest.  
That is a statement of evolution, right?  
First one is based on, if you have more information and if you train your mind with more information, you will be more precise or you will take better decision.  
That is the first one.  
That is based on the first idea.  
 **Speaker\_00 - 52:09**The fourth one is based on which idea?  
Yeah.  
If you want to serve, you need to adapt for different environmental conditions and over a period of time you need to adapt to be the most stable or  
So in that you have two words, one word mutation and one word crossover.  
What is the meaning of mutation and what is the meaning of crossover?  
Mutation is something that happens in the individual gene.  
If there is the algorithm actually makes modifications to individual genes.  
 **Speaker\_00 - 52:55**and it also derives a new gene based on the two parent genes.  
So if there are two parents, the offspring can have genes from both the parents.  
The algorithm tries to take best out of the both parents to give it to the offspring.  
That is called as crossover.  
In the crossover, the algorithm tries to give best features to the offspring from both the parents.  
Mutation is modifying the gene individually.  
after you take the best from both the parents and after taking the best from both the parents is crossover and after taking the best from both the parents on top of that what you can improve is called as mutation and based on that you get best from both the parents and on top of that you improve so  
 **Speaker\_00 - 53:46**that you always try to become better and better so that you will become the best version or the fittest version of you that is how the fourth algorithm works.  
So, I will give you one minute of time just observe the block diagram.  
Just see the block diagram.  
 **Speaker\_03 - 54:17**How many times?  
How  
 **Speaker\_04 - 54:32**many  
 **Speaker\_03 - 54:37**times?  
How many times?  
 **Speaker\_00 - 54:58**So there are five, in total there are five systems that are explained over there.  
System one it names as operations.  
System two it names as coordination.  
System three it names as monitoring and control.  
System four it is intelligence and system five policy.  
Can you correlate those things with a human body?  
For example, if you take operations in the block diagram,  
 **Speaker\_00 - 55:44**in the block diagram on the left here you are seeing the environment.  
The vertical big oval that you are seeing is the whole environment in which there are local environments.  
There is one whole big environment in which there are local environments.  
That is a left vertical oval.  
On the right you have the whole system, whole intelligent system.  
That intelligent system has five subsystems.  
Those are the five subsystems that are there.  
 **Speaker\_00 - 56:21**And the first and primmost subsystem is called as an operation.  
Operation is something that is in direct contact with the environment.  
So if I am the system, if I am the system with that five subsystems, what is the part of operations that is there in my body?  
I am the system and this entire class is the environment for me right now.  
and there are some parts of my system that are in direct contact with this environment.  
What are those?  
Eyes.  
 **Speaker\_00 - 57:01**With eyes I am seeing and I am talking, my skin is feeling the temperature, my legs and my hands, by means of which I am just moving, I am standing and I am doing some tasks.  
So in the operations you have all these.  
Hands, legs, they come under activators.  
So by which you do some task, either walking or holding this mind, all these comes under operations.  
I am seeing and I am doing some task and these all are in direct contact with the environment.  
This is the environment and they are in the direct contact with the environment.  
That is called as an operation.  
 **Speaker\_00 - 57:40**Okay.  
What are the other four?  
Can you name the other four?  
Can you select any one of them and can you just correlate?  
Which part of me is coordination, which part of me is monitoring and control, which part of me is intelligence and which part of me is policy.  
Okay,  
where is intelligence?  
 **Speaker\_00 - 58:16**Where is intelligence in my body?  
It is not the only brain right.  
Again when I ask this question you should ask me a question back whether you are asking in macro level or whether you are asking in micro level that should be your question.  
In macro level if you see me my whole system as a single unit the macro level answers will be different from the micro level answers.  
So now you answer.  
at a macro level, what is intelligence, what is policy, what is monitoring and control, what is coordination.  
At least differentiate between what is intelligence and what is policy.  
 **Speaker\_00 - 59:09**I will tell you, for example if you are trying to cross a road, if you are trying to cross a road.  
vehicles are coming and you are just seeing it with ice.  
Ice are the operations.  
Ice are part of operations.  
I am just seeing the vehicle.  
I know very well whether it is a Lamborghini car or whether it is a road roller.  
If it is a road roller, I know very well that it is going to come very slowly.  
 **Speaker\_00 - 59:35**So I will walk very slowly because I have a feedback.  
My eyes are part of operations and my legs are also part of operations.  
So the information is going from ice to my brain.  
It's going from operations to intelligence and from intelligence again it's coming to operations.  
In between you have this coordination, monitoring and control.  
In between you have this, if you see it at a very high level and the information is coming to my legs to either walk slowly or fastly based on whether it's a high speed car or whether it's a low speed vehicle.  
So you are taking some decision based on the operations and your intelligence.  
 **Speaker\_00 - 01:00:17**whether you have to go fast or whether you have to go slow.  
In this, if a car is coming very fast and you are trying to cross the road, your intelligence says that move as fast as possible so that you will be safe.  
The car is coming very fast and your intelligence says that move as fast as possible.  
But the policy, policy is also in your brain, it says that yeah I know that you should move as fast as possible, but you are not a superman to jump from here to there, there are some constraints, there are some restrictions for a person, there is only certain thing that a human, there are some  
restrictions for the body and there are only something you can do, that is a policy.  
Intelligence tells that, do whatever you want, jump from here, cross the road, do whatever you want.  
That is what is told by intelligence, but the policy tells that you can do, but this is only so and so you can do.  
 **Speaker\_00 - 01:01:22**You cannot run like a horse or you cannot jump like a monkey.  
You are a human and you have some restrictions and in that only you can do the best.  
That is what policy tells.  
Intelligence tells do whatever you want, do this task.  
So the policy actually knows what can be done, what cannot be done.  
Intelligence tells you Do this so that you will be safe or do something, do this.  
Operations will either give the information to you or will finally execute what is told by intelligence or policy.  
 **Speaker\_00 - 01:01:58**But in between there are two more stages.  
You have monitoring and control and you have coordination.  
So operation is something that is outermost which is in direct contact with the environment.  
Operations.  
Policy and intelligence are at a very high level in your system which is taking the final decision what to do.  
But in between to execute this you have two more stages.  
One thing is take monitoring and control.  
 **Speaker\_00 - 01:02:30**So if a signal is going to brain and if a signal is coming from brain, it's not that the signal came from brain and leg is moving.  
In between there are so many other stages.  
Those are your intermediate systems and at every stage For example, if you take monitoring and control, it actually monitors the strengths and weaknesses of the internal parts.  
For example, monitoring strengths and weakness of internal parts means, have you seen leprosy infected people?  
At least pictures of them.  
Or at least have you read about leprosy?  
So most of the people who are infected with leprosy, if you see them, they might have lost their fingers or some other part of the body.  
 **Speaker\_00 - 01:03:22**What is one reason for that?  
What is the reason that they lost those parts?  
Reason is that they lost the sense.  
They don't have that sensory feedback.  
For example, if I keep my hand in the door and if I am closing, If I have leprosy for example, I do not have the sensory feedback that you are having a pain.  
You lose the sense.  
You won't get the sense of pain.  
 **Speaker\_00 - 01:03:52**So there is no feedback that is going to the brain.  
So you tend to keep the hand there only so that the activity goes on and your body will get impacted.  
So there is no sensory feedback there.  
So your internal feedback system is damaged.  
The whole discussion here is about viability means whether your system is being independent and it is stable by being independent there since there is no sensory feedback there is no feedback that something is harming your system your system itself is getting damaged so the monitoring and control is  
actually it's monitoring the internal strengths and weakness for example I tell one more thing Why do you get cardiac arrest?  
Why do you get cardiac arrest?  
 **Speaker\_00 - 01:04:51**Generally speaking, if your system is viable, if a human body is a viable system and say you are doing some activity in gym, your system is supposed to tell you that you are going beyond threshold, stop it.  
Don't go beyond this.  
Either if you don't have such kind of feedback in your system or if there is a feedback and you have overcome that pain, you have trained yourself to overcome the pain, either that or there is no feedback itself.  
It means that your system is not viable anymore.  
So that's why there is no feedback that your body is going beyond your capability.  
So you might end up in cardiac arrest.  
So this monitoring and control actually takes care of the internal health of your system that you are developing.  
 **Speaker\_00 - 01:05:43**So if you develop some system, it might have some arms and legs if it is a robot, for example, or some sensors whichever are directly interacting with the environment.  
But internally there might be some electronics that are there.  
If you are not monitoring, for example, if you open your laptop, you can actually monitor what is the temperature of your IC.  
You can monitor all the temperature of different components within the system.  
If there is a fan failure in your laptop, you will get a feedback that the fan is not working because of that your main microprocessor temperature is raising drastically.  
You will get all the temperature feedbacks of your laptop.  
So all the internal parts of your laptop are not in the part of operations.  
 **Speaker\_00 - 01:06:28**It comes in the part of monitoring and control where you are trying to monitor the health of each and every IC that is there.  
Because that is crucial in order to execute the final operation.  
Similar to monitoring your health of each and every organ in your body, each and every IC in your laptop there is a temperature sensor monitoring the temperature to see whether everything is in a normal state or not.  
So generally whenever your laptop is hot, the fan speed will be very high because a feedback was there that your IC is very hot.  
try to cool it down.  
So your internal system it used a feedback loop.  
It's a negative feedback telling that the temperature is raising drastically somehow cool it.  
 **Speaker\_00 - 01:07:14**So the fan is actually increasing the speed so that the IC will cool down.  
So this comes under the monitoring and control.  
And the last one is the coordination where all these systems have to communicate with each other.  
So the sensors have to give the information.  
The information has to go properly to the proper channel, to the final intelligence and the signal path, from feedback path to the forward path.  
How the signal should go, whether the signals are going or not.  
For example, it's not just that you kept a sensor and you're operating based on that.  
 **Speaker\_00 - 01:07:53**Sometimes the system may fail.  
I'll give you one example of if you take coordination.  
If you take any industry, for example, in industry also there are so many sensors, if you, by chance if you went to some industry, there are so many sensors that are placed in different places.  
You can have flow sensor, you can have temperature sensor, there might be some boilers, turbines, different places in the industry and there will be some signals that are getting transmitted in that entire industry.  
And usually this signal transmission happens by means of current.  
say usually they use 0 milli ah 4 milli amperes to 20 milli amperes.  
So, if there is no temperature like if the boiler is off if there is no temperature so from temperature sensor you will get a reading of 4 milli amperes and if the boiler is at maximum temperature which is beyond the threshold say your signal will be 20 milli amperes.  
 **Speaker\_00 - 01:08:54**Why it is not from 0 to 20 and instead it is 4 to 20. That is also part of developing a safe and reliable system.  
My question is, if a boiler is there, you are trying to monitor the temperature of the boiler.  
If the boiler is in minimum temperature or if it is switch off, you will get a 4 milliampere reading.  
If the boiler is in the maximum temperature, then you will get a 20 milliampere reading.  
The reason why it is 20 milliampere reading is, human body can sustain till 20 milliampers.  
If it is beyond 20 milliampers, if there is some short circuit, human body will get damaged.  
That's why maximum is fixed at 20 milliampers in the signal path.  
 **Speaker\_00 - 01:09:41**But the minimum is fixed at 4 milliampers and not 0 milliampers.  
What is the reason for it?  
So for example, let us say you got 0 ready.  
Let us assume I got a 0. I want to know.  
whether actually the temperature is minimum or whether there is a breakage in the signal or whether there is a failure in the system.  
In both the cases, I get zero signal.  
So to differentiate between that, I want to differentiate whether the actual reading is minimum or whether the system itself is failed, that's why I'm getting a zero reading.  
 **Speaker\_00 - 01:10:17**In order to differentiate that, you have zero for failure and 4 milliampere for telling you the minimum most value in that part.  
So the maximum value is kept based on whether you want to differentiate between a complete failure or a minima.  
The similar system you should have in the system which you develop.  
Even the system which you develop, you should know the difference between failure of a particular subsystem or the minimum reading that it is sending.  
So you should be able to differentiate between them.  
So these things actually come in the coordination.  
 **Speaker\_03 - 01:10:56**So  
 **Speaker\_00 - 01:11:04**there is some similarity between the previous slide and this slide.  
The previous slide was telling about the generic terms.  
Here it says it uses some kind of terminology here.  
When I try to compare the operations, when I told about the operations in the previous slide.  
Here you have data collection sensors and activators.  
That become the part of operations.  
And what are the other parts that you can see here?  
 **Speaker\_00 - 01:11:37**You have this conveyor belts and you have this machines and you have some autonomous ground vehicles.  
All these are the final activators.  
that is going to do that task whichever is told by the intelligence.  
So you have this conveyor belts, like in many companies there will be conveyor belts, or even in your airport there will be a conveyor belt, where you can collect the luggage.  
The belt will be moving and the luggage you can collect it.  
So these are the final activators, like executing the final decision given by the intelligence.  
Those are the activators.  
 **Speaker\_00 - 01:12:17**Data collection is from the sensors.  
Sensors can be, for example, RFID, RFID readers, it can be your, it can be in your ID card, it can be in your books, RFID tags.  
So, these sensor, for example, if in the same airport thing if you can take, instead of you manually selecting which luggage is yours, if you put some RFID tag on to the luggage, and the conveyor belt is moving, and you have some collection system, so wherever you're standing it will come and give  
you the luggage to instead of you going and picking it up.  
For example, a smart system.  
So, RFID is the sensor part and you have the activator part.  
And this sensor and the activator together will come in the operations of whatever I told in the previous slide.  
 **Speaker\_00 - 01:13:04**Other than that you have the other intelligence parts, you have AI techniques, you have cooperative algorithms.  
Cooperative algorithms also comes in the coordination, coordination monitoring and control.  
In those parts you will get the cooperative algorithms and you have the local goals and the global constraints.  
Global constraints are given by the policy.  
You can only do so much.  
I know that you want this, but you can only do so much.  
These are only the maximum thing that you can do are given by the global constraints and the local goals.  
 **Speaker\_00 - 01:13:37**Local goals means what are all the individual small goals each of your subsystem should do in order to achieve a bigger goal.  
That is what is there in this slide.  
Yeah.  
You can take a break for some 10 to 15 minutes and you can come back.  
I'll complete the remaining part.  
And the attendance will be taken after coming back again.  
You can collect the sheets.  
 **Speaker\_00 - 01:14:08**But wait.  
Don't leave.  
You can give back the sheet.  
 **Speaker\_04 - 01:14:18**Okay.  
 **Speaker\_03 - 01:14:47**Sack exam.  
 **Speaker\_04 - 01:14:48**You can't tell.  
 **Speaker\_00 - 01:15:03**After you come back on the back side you again give the attendance in the same sheets.  
 **Speaker\_02 - 01:15:14**Okay,  
 **Speaker\_03 - 01:15:38**look.  
 **Speaker\_00 - 01:15:42**Individually  
they are intelligent to some extent, but not that an individual entity can do the final task.  
Only together they will be able to achieve that task.  
Such systems are called collective systems.  
Some examples that you can see is ant colonies.  
honeybees, flock of birds, these are some examples.  
So, there are some principles for these collective systems.  
 **Speaker\_00 - 01:16:19**One thing is the self-organization in these systems happen by either a positive feedback or a negative feedback.  
and there is some equation over there and there are some this actually mathematical representation of the collective system where whether the system will be diminishing or whether it will be increasing over a period of time based on the different task for different ranges of values of R based on the  
equation you can actually tell how the system is going to evolve you can actually experiment with those values later after the class you can just substitute the values and you can check whether it's matching or not.  
So you can go to the next.  
So coming to the actual idea in a collective system, whether it's a group of ands or whether it's a group of bees, in a collective system, there are two kinds of communications that are possible.  
One thing is by means of Q and one thing is by means of signal.  
Something can be called as a signal if it says that, for example, if I say that all of you stand up, for example, if I say it's a signal and it's an instruction and you will be following them, that is a signal.  
 **Speaker\_00 - 01:17:40**Whereas a queue, for example, I am just walking around and if this person is there, he might see that I am walking and he might move his leg aside.  
That's not a direct signal, but it's an indirect observation that he might take or he might not take.  
Some people might think that, okay, let me move so that he will move forward.  
Some people, I don't care, I'll sit like this, only you do whatever you want.  
So that is a cue.  
A signal means you have to follow it.  
A cue means you may or you may not follow.  
 **Speaker\_00 - 01:18:11**It's up to you.  
So, for example, if there are some group of ants that are going, if a ant signals that there is some danger or there is a food, it communicates very clearly to the other ants and they follow.  
But whereas there is one example that is written over there, for example, some insects are moving in a path, in a path, some dump that is formed.  
It's not a direct signal, it's a queue.  
The back sides, the insect might follow it or might not follow it, it's up to them.  
It might take it as a positive feedback or it might take it as a negative feedback.  
It's its wish, because it's not a fixed signal, it's a queue.  
 **Speaker\_00 - 01:18:49**So there are two things, one is queue and one is signal and you have to, One is intentional and one is unintentional.  
One is intentional and one is unintentional.  
For example, if a goat is going forward, all the goats will be following that goat.  
Is it a signal or is it a cube?  
The before goat is not telling the other goats to follow it.  
It's not a signal.  
Next.  
 **Speaker\_00 - 01:19:18**For example, if you take species, group of species, something is called as an aggregation.  
which you can see, have you watched the videos of group of fish, group of fish, moving in ocean or see have you seen the videos of it?  
Have you all seen the videos of it?  
If a group of fish has to move, if a group of fish has to move, a fish shouldn't collide with the other fish at the same time the distance between any two like distance between the fish should not be too large say the maximum dimension of that group of fish is 10 meter cross 10 meter the maximum  
distance between two fish shouldn't be more than 10 meter and at the same time they shouldn't collide with each other so if they are moving in a zigzag path all of them also should follow that zigzag path If they're moving in a straight path, it's fine.  
But if you're moving in a zigzag path, all of them should take the same path, otherwise they start colliding among themselves.  
How do they do that?  
 **Speaker\_00 - 01:20:28**So each and every fish, like is there any leader for them telling that you take 30 degree angle, you take 40 degree angle, you take 60 degree angle.  
Is there any leader fish telling that for them?  
Each and every fish does that task.  
Each and every fish look at the all the nearby fishes.  
It just estimates the amount of distance between it and the opposite fish.  
If it is going very close to a fish, it will take it as a negative feedback and it will slow down.  
If it is very far away from so many fishes, it will take it as a positive feedback and it will try to move towards the fish.  
 **Speaker\_00 - 01:21:01**So, one thing is that it has to maintain some distance, but it shouldn't collide or it shouldn't be too far that it is moving away from the group.  
If there is a fish that it sees that it is not part of group anymore, it is left out somewhere in the ocean.  
So, it has to search for its group.  
So, it has to randomly search.  
That comes in the fourth point.  
So a fish is checking the distance, based on the distance it is taking either a positive feedback or a negative feedback, how much distance it has to maintain.  
So it will have some sense.  
 **Speaker\_00 - 01:21:34**Okay, the distance between this fish, this fish and my neighboring fish is 10 centimeter.  
So, these are safe distance, I will be maintaining this.  
Just like that vanet architecture where pass are moving, the before car is moving with some speed, backside car also is moving with some speed.  
So, before car suddenly applies a brake.  
If that communication is not there, back car will go and hit the before car.  
So if the communication is proper, that a sudden brake is applied in the before car, even if the driver is not applying the brake, there will be an automatic system applying the brake for it, so that the cars won't collide.  
So similar idea that is taken from push.  
 **Speaker\_00 - 01:22:09**So all of them, all the cars that are moving on the roads in a zigzag path shouldn't be too far or shouldn't collide, but they have to follow the path to achieve the goal.  
That is called as an aggregation.  
Next slide.  
So clustering and sorting, aggregation is one intelligence that is there in the group.  
Clustering and sorting is the other intelligence that is there.  
You can see in ants.  
So what do they do?  
 **Speaker\_00 - 01:22:38**They just cluster, cluster the eggs.  
So they have to feed the eggs or they have to give the food.  
So they categorize the eggs that are there into multiple baskets.  
Okay, these are this much years old, this need this much nutrition.  
These are this much year old, they need this much nutrition.  
So the eggs, if they are randomly arranged in the nest, they segregate them so that it will become easy for them.  
Just like books are arranged in the library, they segregate them for the ease of task.  
 **Speaker\_00 - 01:23:07**So that is called as aggregation and clustering.  
And how do they do that?  
For example, say, There are some grains, there are some grains that I put it on the floor and I leave some few ants there.  
How do ants make heap out of them?  
What is the natural, like there is no leader ant telling to each and every ant that you go and collect that grain, you go and collect this grain.  
There is no leader ant telling to group of ants.  
Each and every ant.  
 **Speaker\_00 - 01:23:37**lifts up the grain based on the probability of the grains it comes across in its path.  
For example, if it is walking on the path, I just put some rice grains here or some wheat grains here.  
The ant is moving.  
If it comes across grains very frequently, it means that it's already a heap.  
If it is coming across grains very sparsely, very sparsely, then whichever is outlayer or whichever is very sparsely placed, it tries to pick up and come and place it in the place where the group is more.  
So that is the natural sense of every ant.  
That is how the ant behaves.  
 **Speaker\_00 - 01:24:16**So each and every ant on its path tries to pick up the sparse grains from sparse places and try to drop it in the dense places.  
So each and every and does the same task.  
So what will happen collectively?  
There are thousand grains, hundred and each and every and its natural sense is that it should collect the sparse grains and dump it in the dense place.  
If each and every and does the same task, ultimately the final outcome is the grains which are very sparse on the floor will either become two heaps or three heaps.  
if all the ants are doing.  
So here there is no single leader to them who is telling to do that.  
 **Speaker\_00 - 01:24:58**Each and every ants natural sense itself is to do that.  
To collect the sparse things and to place it in the dense things.  
That is how they do the clustering and sorting.  
Next slide.  
So there is something called as foraging.  
That is also one of the intelligent behaviors of the ant.  
Say there is source and destination.  
 **Speaker\_00 - 01:25:22**there is source of food and there is a destination.  
Destination is the ant nest.  
Initially a few ants will go and find the food and they come and communicate that there is a food.  
And some group of ants will try to form the path.  
Like let us assume they form some two, three paths.  
The first path is in the form of a curve, very long one.  
The second path is the straight line curve and some other path is some zigzag curve.  
 **Speaker\_00 - 01:25:47**They found three paths and they themselves don't know that which path they are following.  
So they start following all the three paths to collect the food.  
Slowly what happens is as long as they are moving in the path, they release some chemical on the path, in whichever path they are taking.  
Like out of 100 ants, say 30 ants took the longest path.  
remaining 30 ants took the second longest path, 40 ants took the shortest path.  
So, they will be traveling between the source and destination and as long as they are traveling between the source and destination, they will be leaving the chemical along the path.  
The moment it reaches the destination with respect to time, the ants that are reaching the destination faster are the ones which are traveling from the shortest path.  
 **Speaker\_00 - 01:26:36**So they tend to move back in the same path, even the other ants slowly start following the ants which are frequently coming back.  
So slowly all of them converge to the shortest path.  
So they keep releasing the chemical and they keep converging.  
And finally ultimately all the three paths will converge into a single path and it will be the shortest path.  
So you can test it in your home.  
You can disrupt the path and you can observe what is happening.  
It will ultimately converge to a single path and that will be the shortest path.  
 **Speaker\_00 - 01:27:09**It is based on the chemical that each and every ant is releasing.  
It is again communication between each of the ants that is making this collective intelligence to happen.  
Next slide.  
Till the last.  
So we completed the bio-inspired adaptive systems was covered in the first class.  
In today's class we covered AI techniques, theory of living systems, theory of viable systems and collective system model.  
And what will be happening on Saturday's class, I will be informing through email.  
 **Speaker\_00 - 01:27:52**Theory part is over.  
I'll let you know what will be there on the Saturdays class.  
There are two more classes left.  
One is on Saturday and one is on 17th.  
I'll be letting you through the email.  
You can leave the class.  
 **Speaker\_01 - 01:28:18**Badri  
 **Speaker\_04 - 01:28:36**cafe.  
 **Speaker\_02 - 01:28:45**Thank  
 **Speaker\_04 - 01:28:52**you.  
 **Speaker\_01 - 01:28:55**My vote is for I don't know bro.  
Are you standing up or are they?  
No, she's sitting down for writing test.  
Too much cold air.  
 **Speaker\_03 - 01:29:21**Because you are hot.