GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

Department of Computer Science and Engineering

Value Added Course

On

Optimization for Machine Learning

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA

Department of Computer Science and Engineering

Ref. No.: CSE/3564 Dated: 03/02/2025

NOTICE

A **"Value Added Course"** is being organized for B.Tech (CSE) students from 8rd February, 2025 onwards.The details for the same are as follows:

Title: **"Optimization for Machine Learning"**

Session: Feb-Jul 2025

Mode: Online

Contents to be covered: Annexure Attached

Link for Registration: https://forms.gle/jiEtNGTRFTJW1VdY7

Expert: Mr. Shivam Gupta, IIT Ropar

For more information students may contact Prof. Palak Sood, Assistant Professor, CSE Department.

HOD (CSE)

CC: Department Website

Office Copy

Department Notice Board

Course Plan

Optimization in Machine Learning

Duration: 1.5-hour Lecture per week
Instructor: Shivam Gupta, Ph.D. Research Scholar, IIT Ropar, Punjab, India.
https://shivi98.online

Week	Topic	Lecture/ Lab
1	Introduction to Optimization Theory	Lecture
2	Introduction to Convex and Non Convex Functions	Lecture
3	Gradient Descent	Lecture
4	Gradient Descent	Lab
5	Types of Gradient Descent	Lecture + Lab
6	Gradient Descent with Momentum	Lecture + Lab
7	Adam Optimization	Lecture
8	Adam Optimization	Lab
9	Newton Raphson Method	Lecture + Lab
10	Gauss Newton Method	Lecture + Lab
11	Introduction to Linear Programming	Lecture
12	Linear Programming in Python	Lab
13	Linear Programming in Python	Lab
14	Non-Linear Programming	Lecture
15	Dual Problem	Lecture
16	KKT conditions and SVM	Lecture + Lab
17	Coordinate Descent	Lecture
18	Coordinate Descent	Lab
19	Max-Min Problems	Lecture
20	Max-Min Problems	Lecture + Lab
21	Other Advance Methods (if time permits)	Lecture + Lab

Table 1: Optimization in Machine Learning week-wise course layout.

Optimization in Machine Learning

Instructor: Mr. Shivam Gupta (Ph.D. IIT Ropar, Postdoctoral Research Scientist, IISc Bangalore)
Duration: February 2025 – July 2025
Mode: Online | Weekly | 1.5 Hours per Session
Total Sessions: 25

Introduction

The Department of Computer Science and Engineering, Guru Nanak Dev Engineering College (GNDEC), Ludhiana, organized an Online Value-Added Course on *Optimization in Machine Learning* starting from February 2025. This course is designed to provide students with a deep understanding of optimization techniques that form the backbone of modern machine learning. Through lectures and hands-on labs, participants will gain exposure to theoretical foundations, practical algorithms, and advanced methods widely used in AI and data science applications.

About the Instructor

Mr. Shivam Gupta
Postdoctoral Research Scientist, IISc Bangalore | Ph.D. (IIT Ropar) | PMRF Scholar IIT Ropar | AI Researcher | FairML | Fullstack Developer | IITian | NIT Kurukshetra | IIITian | Innovator | GATE Qualified

Mr. Shivam Gupta is an accomplished researcher and technologist specializing in optimization and artificial intelligence. With a Ph.D. from IIT Ropar and current postdoctoral research at IISc Bangalore, he has made significant contributions in the areas of machine learning, fair AI systems, and algorithmic optimization. A recipient of the prestigious PMRF scholarship, he brings a unique blend of academic rigor and practical industry expertise, inspiring students to bridge theory with impactful real-world applications.

Course Objectives

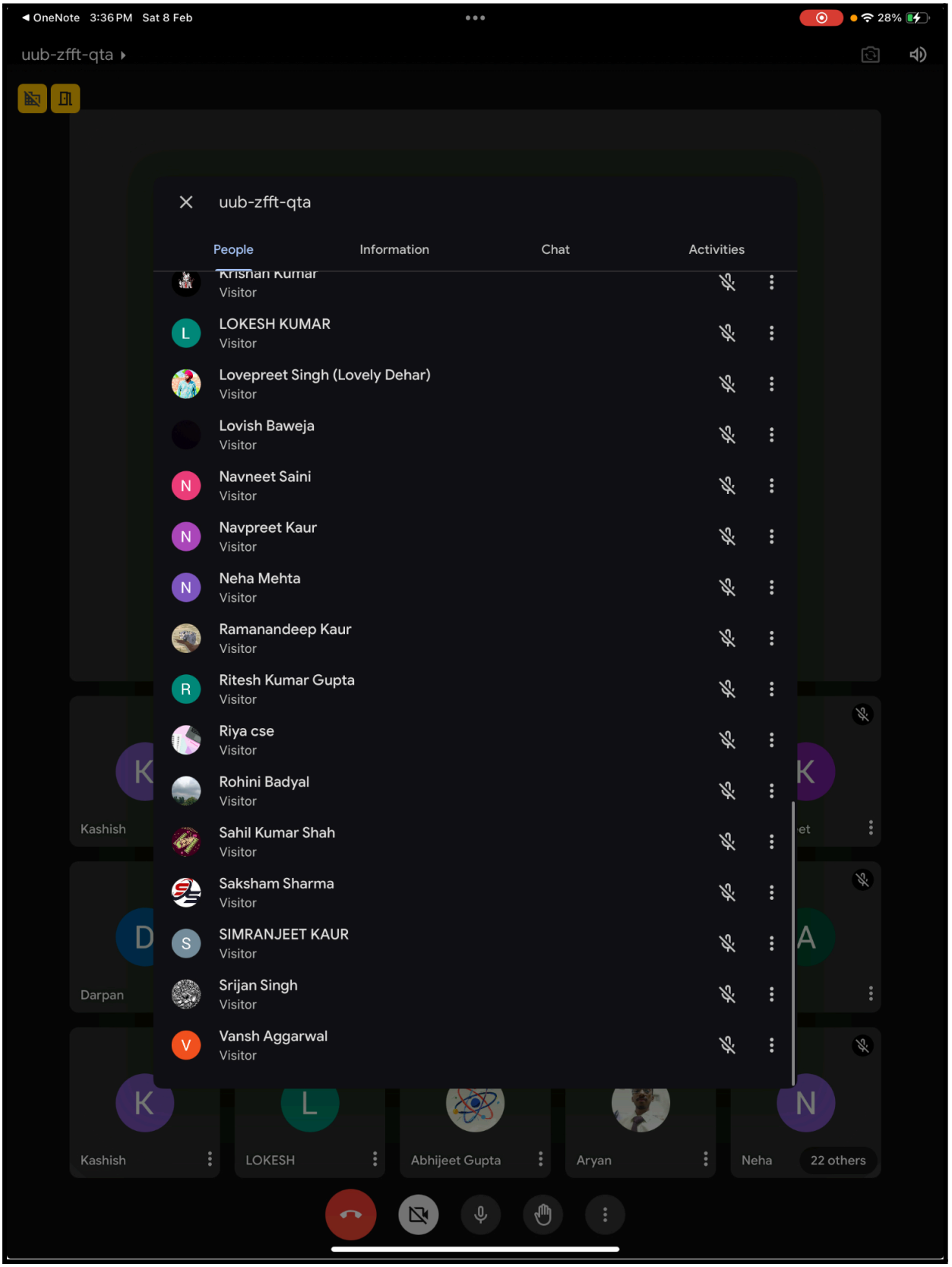
- To understand the fundamentals of optimization theory in machine learning.
- To explore convex and non-convex optimization functions.
- To study gradient descent and its advanced variants including momentum and Adam optimization.
- To apply Newton-Raphson and Gauss-Newton methods in optimization.
- To gain hands-on experience with linear and non-linear programming using Python.
- To understand dual problems, KKT conditions, and their role in Support Vector Machines (SVM).
- To learn coordinate descent, max-min problems, and other advanced optimization techniques.
- To prepare students for real-world machine learning challenges by blending theory with practical lab-based sessions.

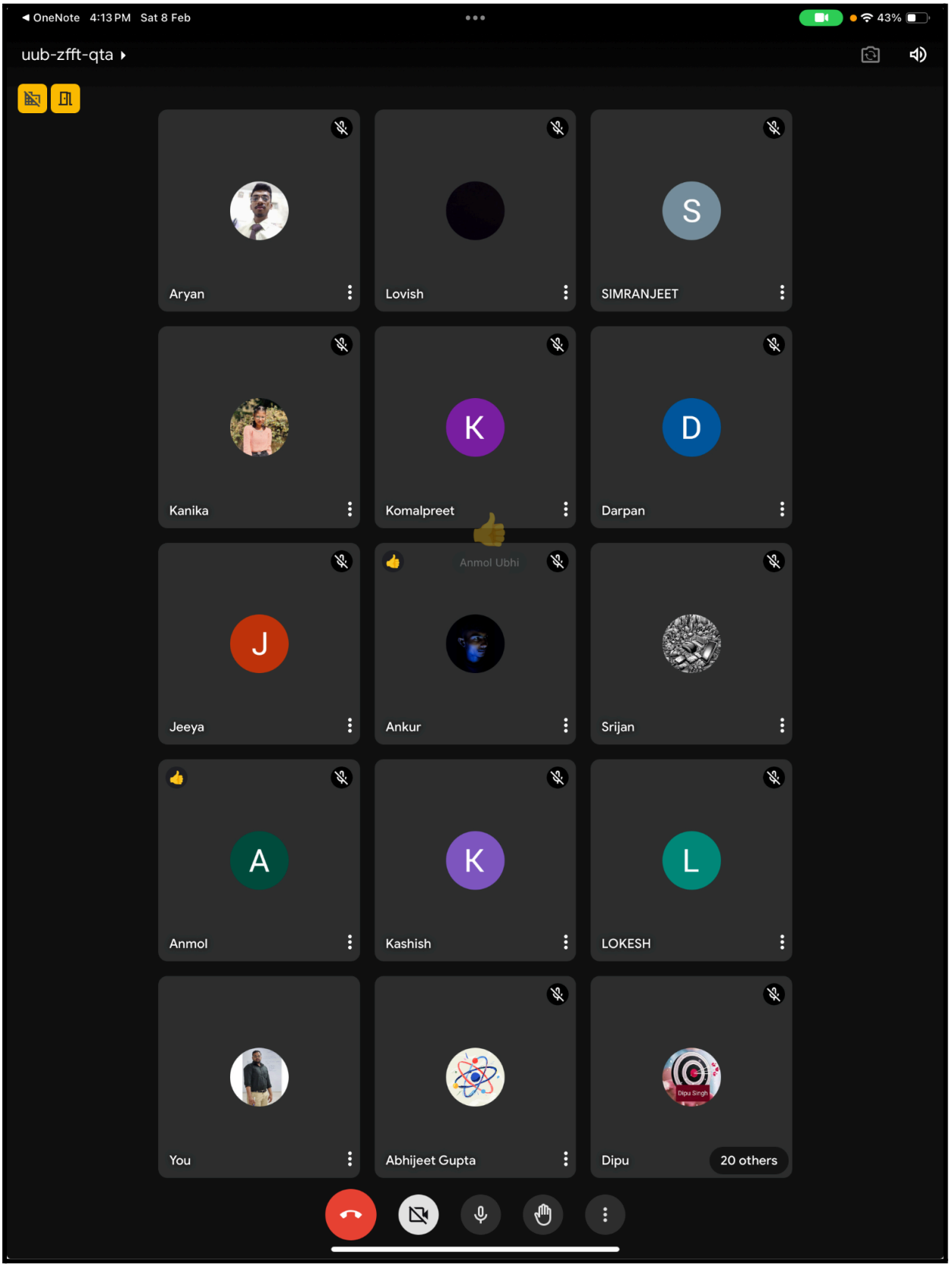
List of Students

S.No	Name	S.No	Name
1	Aadarsh Kumar	47	Kedeep singh
2	Aashima	48	Khushi Kumari
3	Abhijeet Gupta	49	Khushleen kaur
4	Abhishek Singh	50	Kiranjeet kour
5	Aditi Kothari	51	Kirat
6	Aditi Tangri	52	Komalpreet Kaur
7	Alisha	53	KRISHAN KUMAR
8	Anhad Kaur	54	Livtar Singh
9	Ankur	55	Lokesh kumar
10	Anmolpreet singh	56	Lovepreet Singh
11	Ansh tyagi	57	Lovish Baweja
12	Aryan Prajapati	58	Navneet Saini
13	Ashmeen Kaur	59	Navpreet Kaur
14	Bhamini	60	Neha Mehta
15	Bhumi	61	Nirmit Rampal
16	Chandan	62	Nishtha Jain
17	Darpan kumar	63	Nitin Choudhary
18	Deepshikha	64	Nitin Kumar
19	Dipu kumar singh	65	Prasann kumar
20	Divyanshi	66	Rajpreet kaur
21	Diya Baweja	67	Ramandeep Kaur
22	Gunjan Sohal	68	Ritesh Kumar Gupta
23	Gurjot Kaur	69	Riya Sharma
24	Gurpreet kaur	70	Rohini
25	Gursahib Singh	71	Rohit
26	Gursharan Kaur	72	Roshan Kumar
27	Gurveer Singh	73	Sahil Arora
28	Hardeep Kaur	74	Sahil Kumar
29	Harinder kaur	75	Sahil Kumar Shah
30	Harjot Kaur	76	Saksham Sharma
31	Harleen Kaur Bhullar	77	Shivansh Vishwakarma
32	Hartej Singh	78	Simranjeet Kaur
33	Ishaan garg	79	Simranjeet singh
34	Jaideep Randhawa	80	Simranjot kaur gill

35	Jaivivek Singh	81	Srijan Singh
36	Janvi	82	Vansh Aggarwal
37	Jashanpreet Kaur	83	Vikram kumar
38	Jaya Subedi	84	Vishal Rout
39	Jeeya Thapar	85	Vishnu
40	Kajal	86	Vivek rautela
41	Kanika Mittal	87	Anmol Ubhi
42	karan sharam	88	Sohail Singh
43	Karan Singh	89	Arvind Gujral
44	Kareena	90	Shiv Kumar
45	Kashish Gujral	91	Mr Gamer
46	Jot Sharma	92	Aashima Mehra

Screenshots




OneNote 4:13 PM Sat 8 Feb
43%
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Aryan
Lovish
S
SIMRANJEET
Kanika
K
Komalpreet
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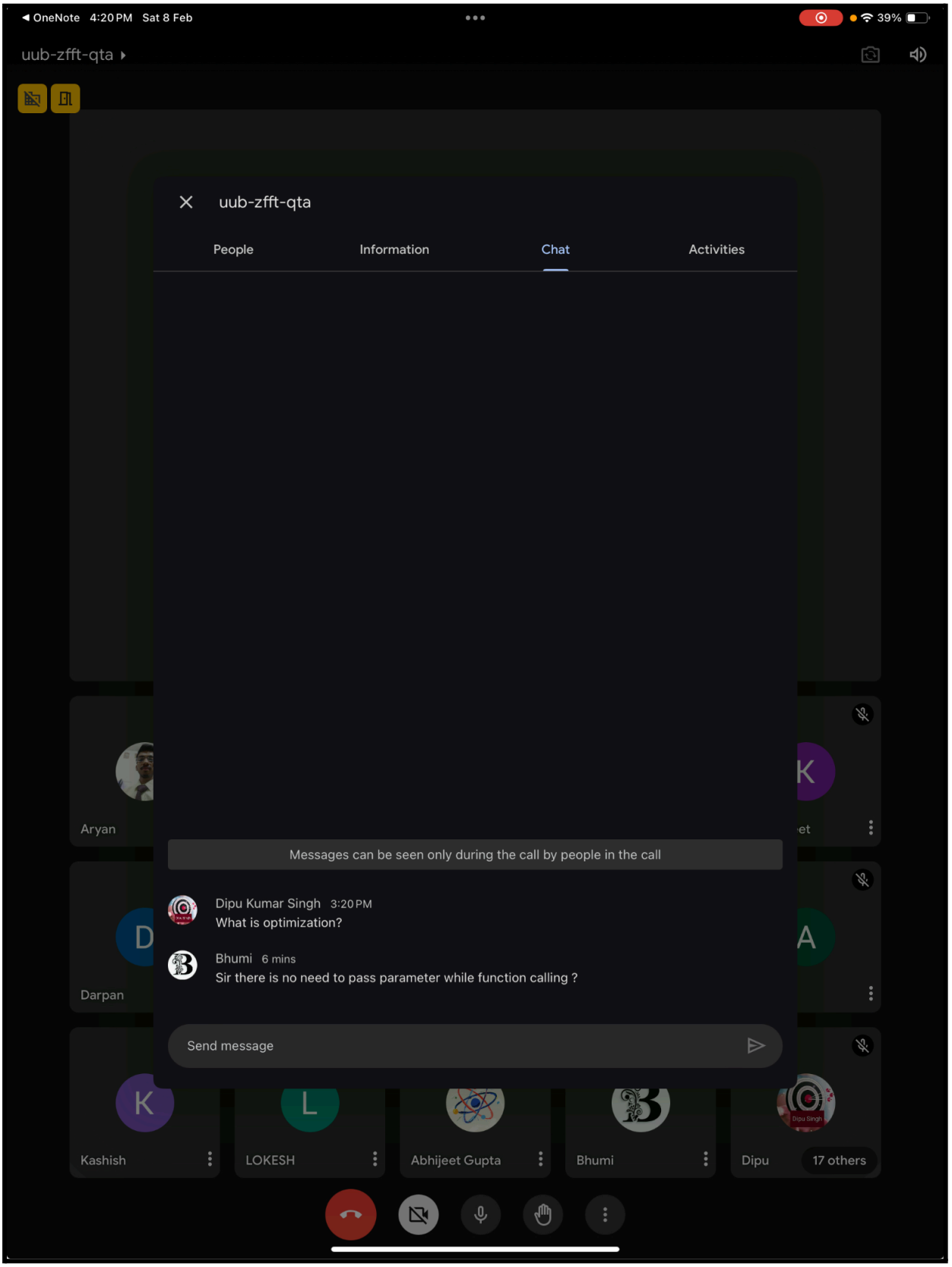
Darpan
Anmol Ubhi
J
Jeeya
Ankur
Srijan
A
Anmol
K
Kashish
L
LOKESH
You
Abhijeet Gupta
Dipu
20 others


OneNote 4:20 PM Sat 8 Feb
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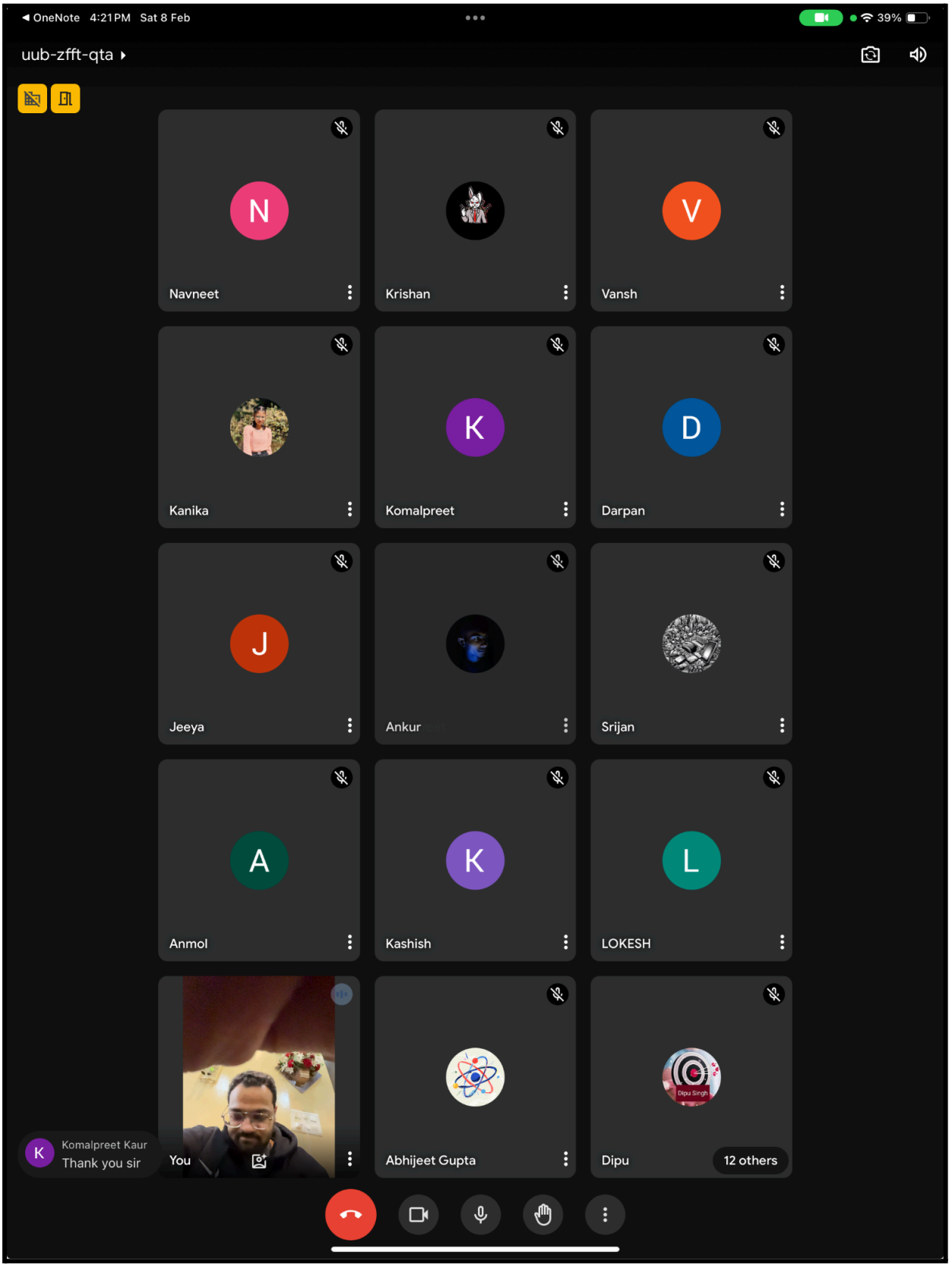
People
Information
Chat
Activities
Messages can be seen only during the call by people in the call
Dipu Kumar Singh 3:20 PM
What is optimization?
Bhumi 6 mins
Sir there is no need to pass parameter while function calling ?
Send message
Aryan
Darpan
Kashish
LOKESH
Abhijeet Gupta
Bhumi
Dipu
17 others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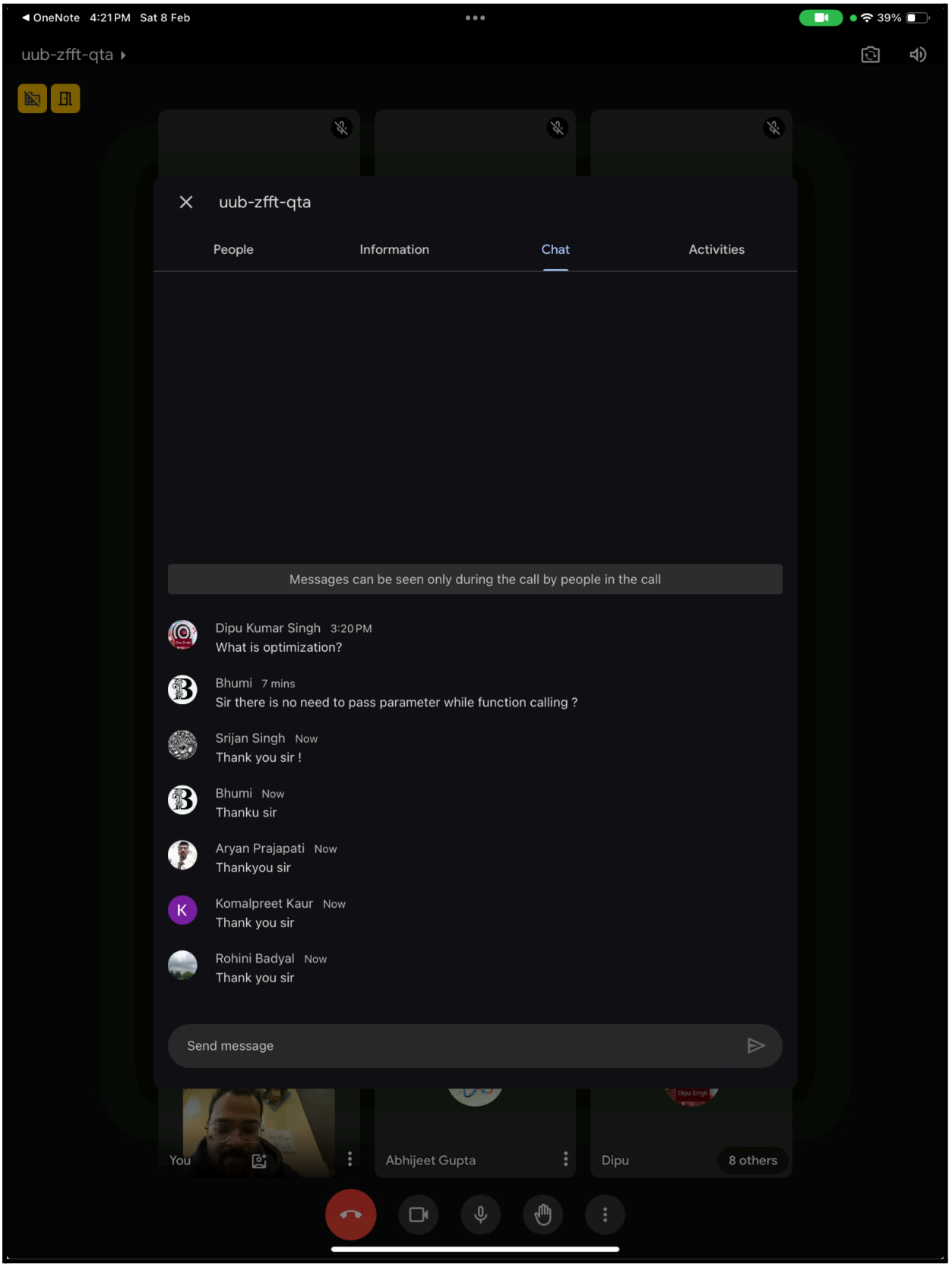
Navneet
Krishan
Vansh
Kanika
Komalpreet
Darpan
Jeeya
Ankur
Srijan
Anmol
Kashish
LOKESH
You
Abhijeet Gupta
Dipu
12 others
Komalpreet Kaur
Thank you sir


OneNote 4:21PM Sat 8 Feb
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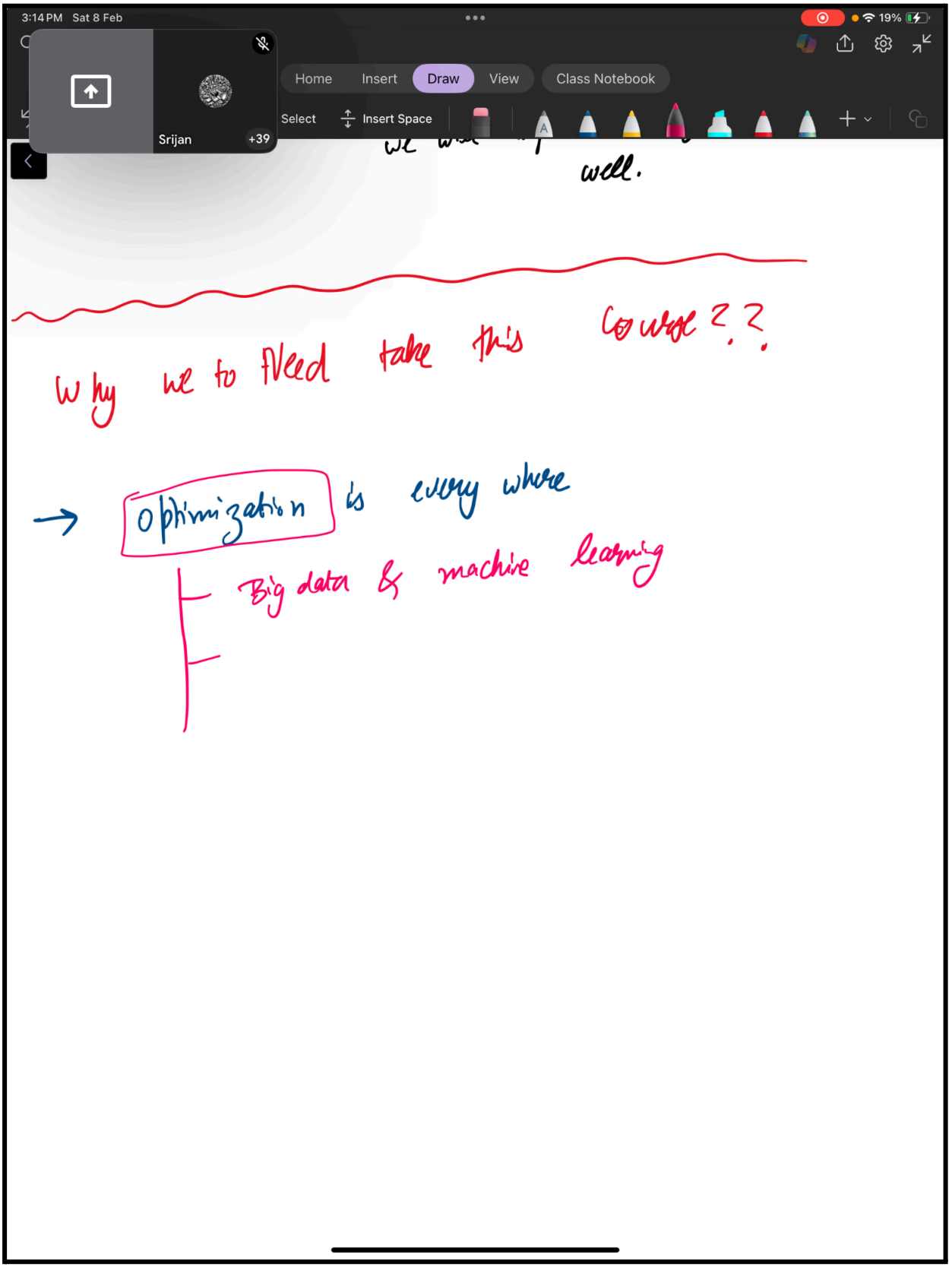
uub-zfft-qta
People
Information
Chat
Activities
Messages can be seen only during the call by people in the call
Dipu Kumar Singh 3:20 PM
What is optimization?
Bhumi 7 mins
Sir there is no need to pass parameter while function calling ?
Srijan Singh Now
Thank you sir !
Bhumi Now
Thanku sir
Aryan Prajapati Now
Thankyou sir
Komalpreet Kaur Now
Thank you sir
Rohini Badyal Now
Thank you sir
Send message
You
Abhijeet Gupta
Dipu
8 others


3:14 PM Sat 8 Feb
19%
Srijan
+39
Home
Insert
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Class Notebook
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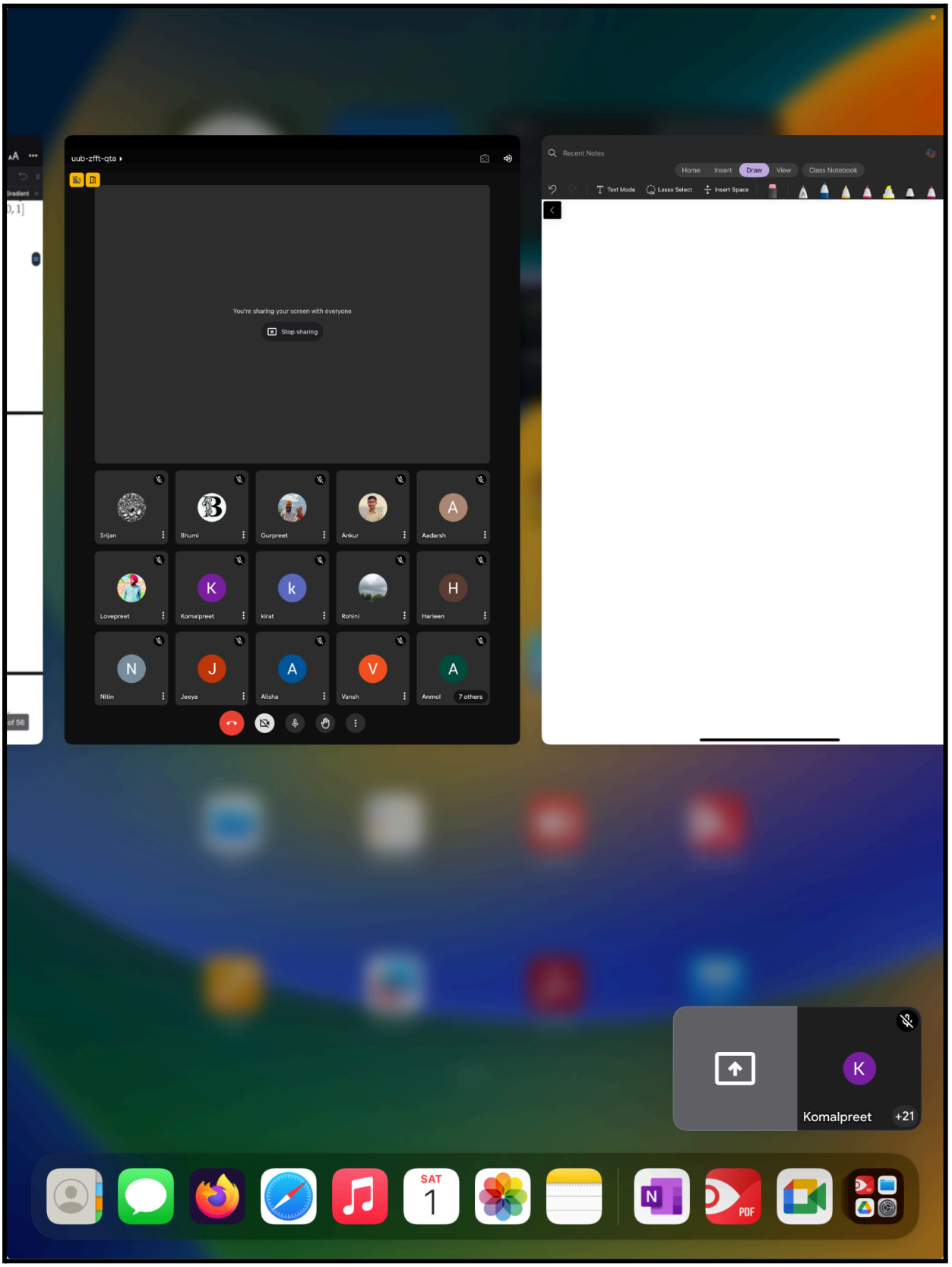
Insert Space
well.
Why we to need take this course ??
optimization is every where
Big data & machine learning


uub-zfft-qta
You're sharing your screen with everyone
Stop sharing
Srijan
Bhumi
Gurpreet
Ankur
Aadarsh
Lovepreet
Komalpreet
kirat
Rohini
Harleen
Nitin
Jeeya
Alisha
Vansh
Anmol
7 others
Recent Notes
Home
Insert
Draw
View
Class Notebook
Text Mode
Lasso Select
Insert Space
Komalpreet
+21
SAT
1
PDF

Get near to a minimum $\mathbf{x}^\star$ / close to the optimal value $f(\mathbf{x}^\star)$?

(Assumptions: $f : \mathbb{R}^d \to \mathbb{R}$ convex, differentiable, has a global minimum $\mathbf{x}^\star$)

Goal: Find $\mathbf{x} \in \mathbb{R}^d$ such that

$$f(\mathbf{x}) - f(\mathbf{x}^\star) \leq \varepsilon.$$

Note that there can be several global minima $\mathbf{x}_1^\star \neq \mathbf{x}_2^\star$ with $f(\mathbf{x}_1^\star) = f(\mathbf{x}_2^\star)$.

Iterative Algorithm: choose $\mathbf{x}_0 \in \mathbb{R}^d$.

$$\mathbf{x}_{t+1} := \mathbf{x}_t - \gamma \nabla f(\mathbf{x}_t),$$

for **timesteps** $t = 0, 1, \ldots,$ and **stepsize** $\gamma \geq 0$.

Example