



भारतीय भूवैज्ञानिक सर्वेक्षण

GEOLOGICAL SURVEY OF INDIA

Introduction to Machine Learning - I

Sabyasachi Nag

Sr. Geophysicist, NM1B-CHQ, GSI



Outline

- Introduction to Artificial Intelligence and Machine Learning
- AI/ML Use Cases in GSI & other Public Welfare
- Conclusion

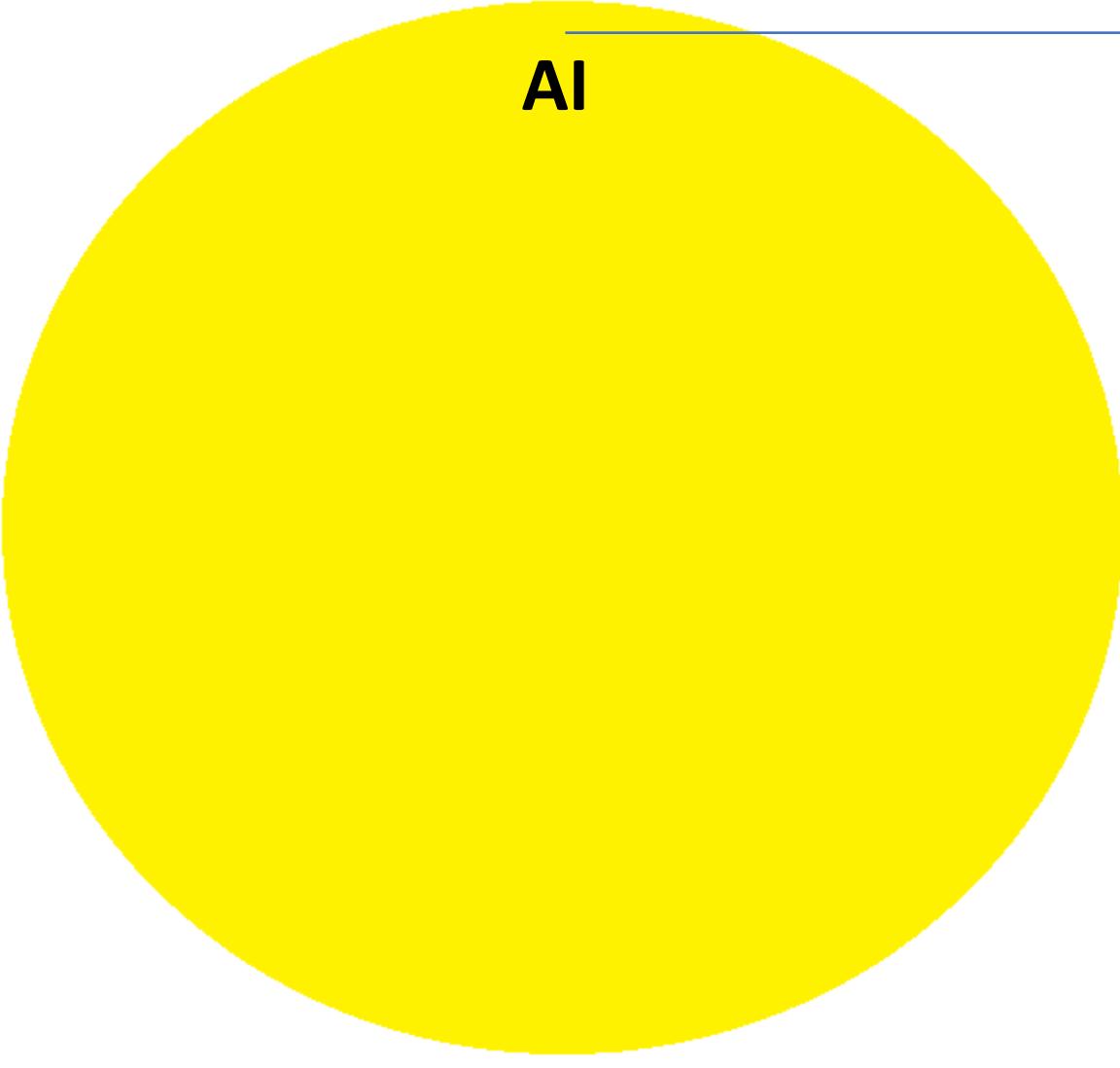




Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL)



Overview of AI, ML, DL

A large yellow circle occupies the left side of the slide. Inside the circle, the letters "AI" are written in a bold, black, sans-serif font.

AI

AI: Machines that can perform tasks which usually requires human level intellect/skills



Overview of AI, ML, DL

AI

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- Rule-based(no new learning)
 - Automatic gates of Metro Trains
 - Computer Chess player





Overview of AI, ML, DL

AI

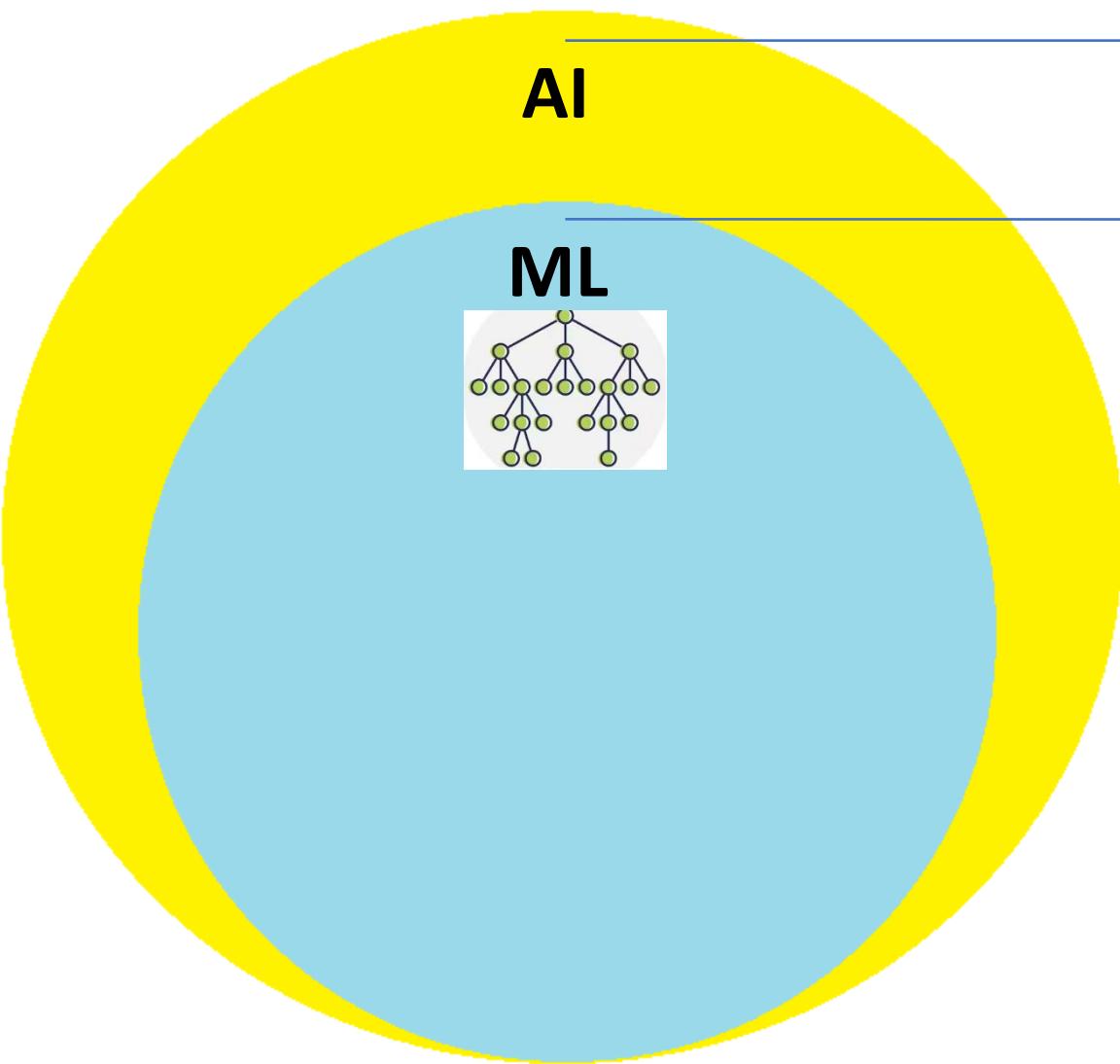
AI: Machines that can perform tasks which usually requires human level intellect/skills

- Rule-based(no new learning)
 - Automatic gates of Metro Trains
 - Computer Chess player
- Non-rule based (Learns from examples)
 - Face unlock on mobile phone
 - Netflix recommendation





Overview of AI, ML, DL

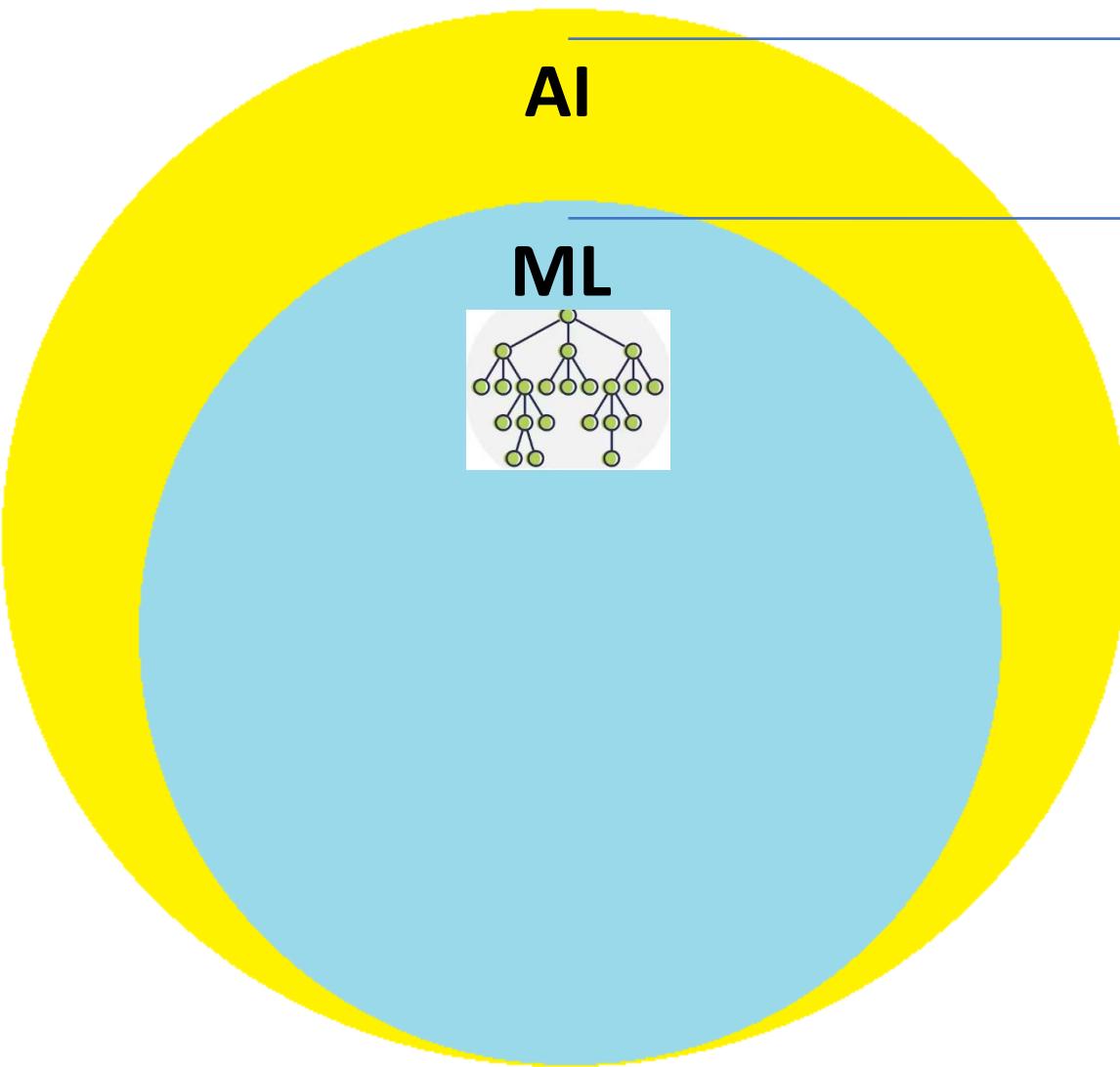


AI: Machines that can perform tasks which usually requires human level intellect/skills

ML: Machines that learn from data/patterns without being explicitly programmed (non rule based)



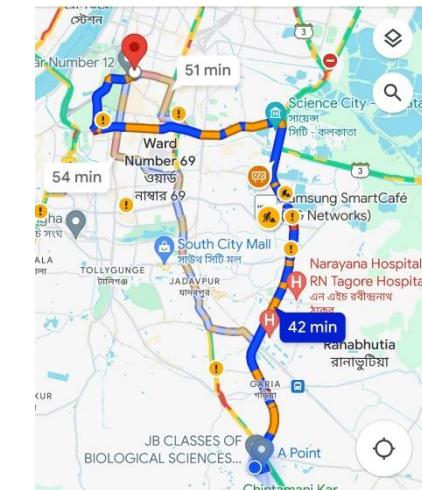
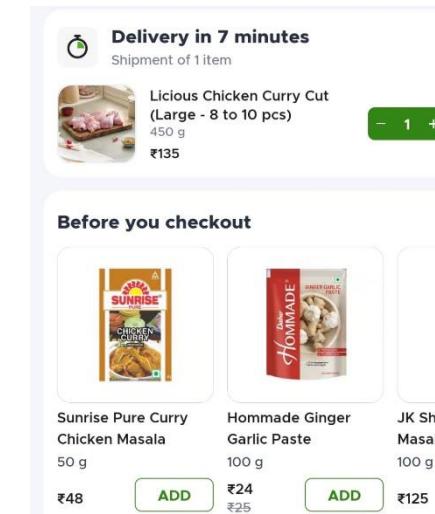
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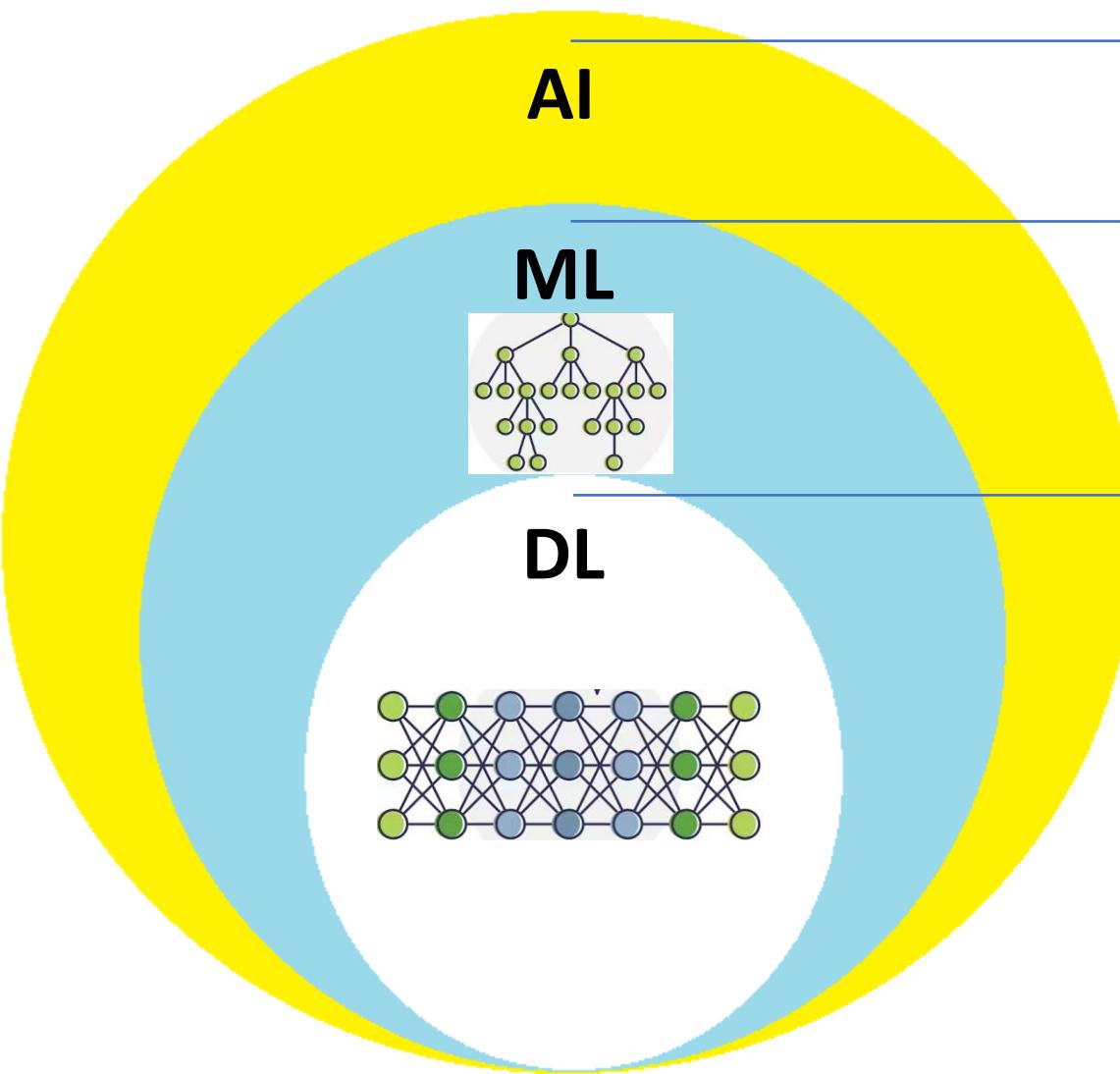
ML: Machines that learn from data/patterns without being explicitly programmed

- Recommendation systems on e-commerce
- Fastest route finder on map
- Facebook auto-tagging





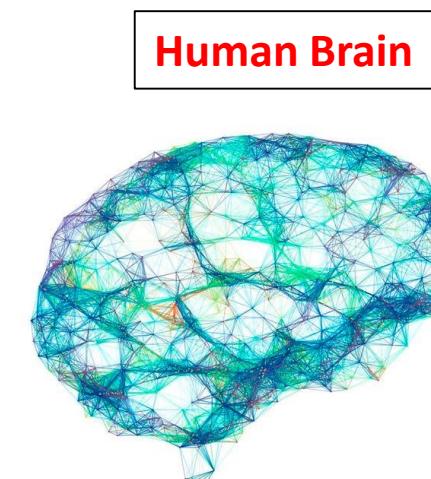
Overview of AI, ML, DL



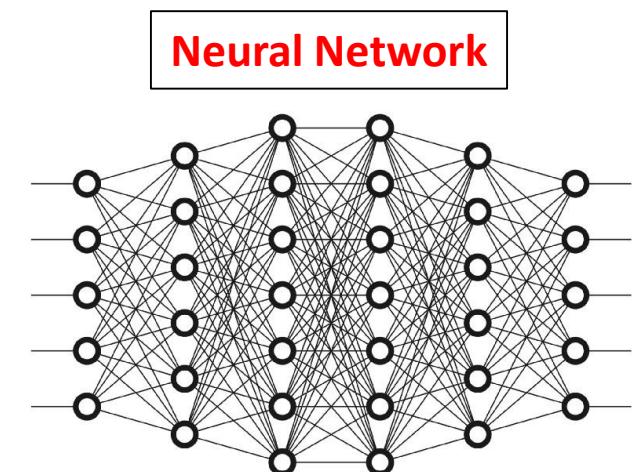
AI: Machines that can perform tasks which usually requires human level intellect/skills

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DL: A subfield of ML that mimics human brain/nerves through multilayer artificial neural network



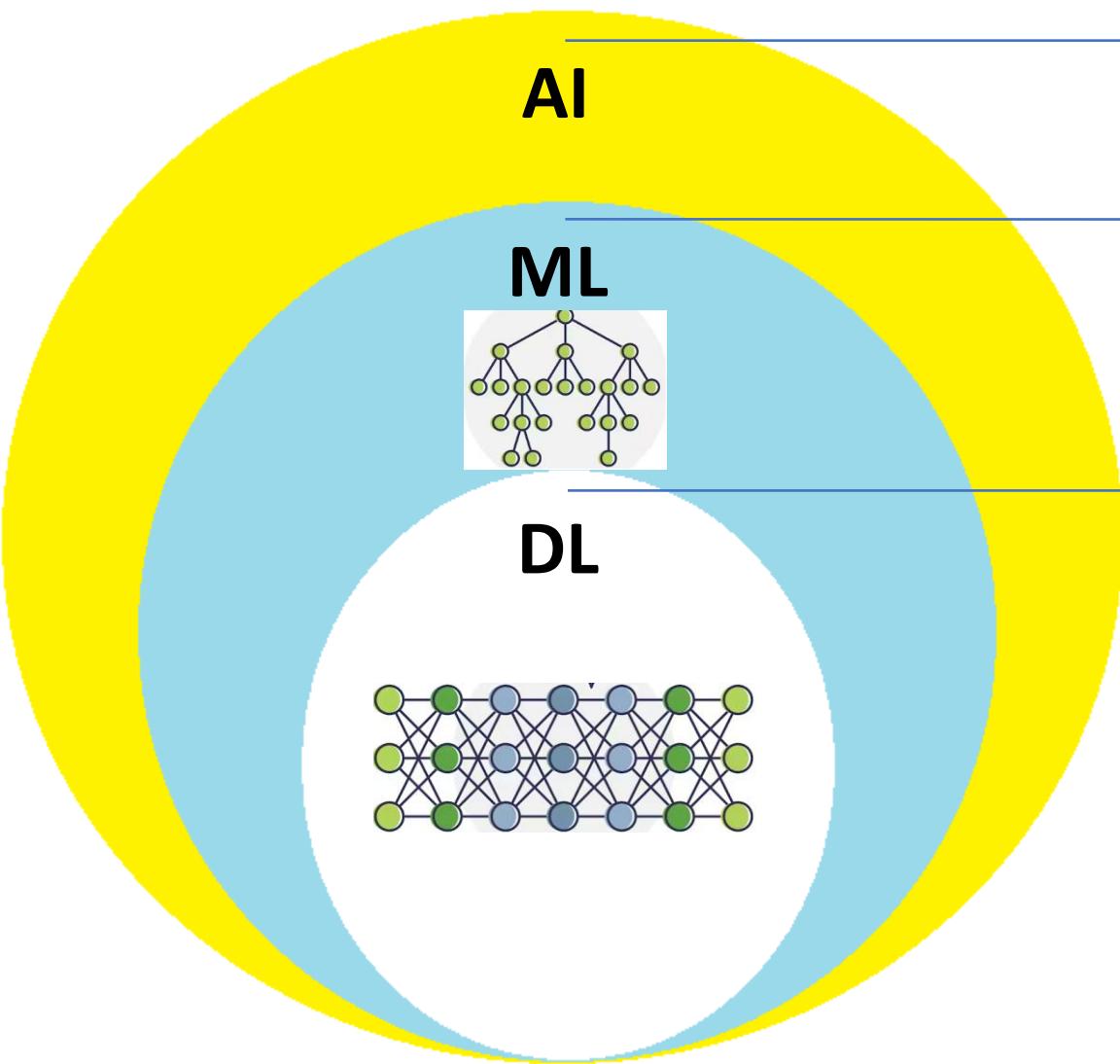
Human Brain



Neural Network



Overview of AI, ML, DL



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DL: A subfield of ML that mimics human brain/nerves through multilayer artificial neural network

- Self-driving car
- Google Translate
- Chat-GPT
- Drug discovery





How AI/ML/DL (Usually) Works?

Input

0 0 0 0 0 0 0 0 0 0
1 1 1 1 1 1 1 1 1 1
2 2 2 2 2 2 2 2 2 2
3 3 3 3 3 3 3 3 3 3
4 4 4 4 4 4 4 4 4 4
5 5 5 5 5 5 5 5 5 5
6 6 6 6 6 6 6 6 6 6
7 7 7 7 7 7 7 7 7 7
8 8 8 8 8 8 8 8 8 8
9 9 9 9 9 9 9 9 9 9

Output

0
1
2
3
4
5
6
7
8
9

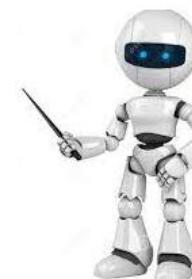


Training Phase: Learn From Known Examples

- Machine ‘Learns’ Numerical digits
 - Identifying curves/patterns



3



Hey human,
It's a Three!

Testing Phase: Predict the unknowns

- Machine looks for similar patterns
 - To recognize unseen digits



AI for Public Welfare



AI in Agriculture

- Pest control in cotton cultivation ([Wadhwani Foundation, Govt. of Telangana](#))
 - **CottonAce** Mobile App. Based alert/prescription model



AI-based Pest Management App

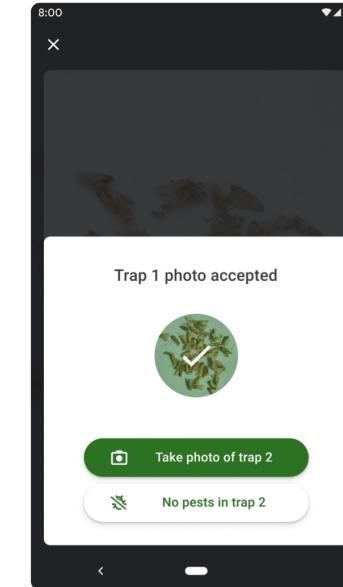
A farmer or extension worker empties the moths from the pheromone trap.



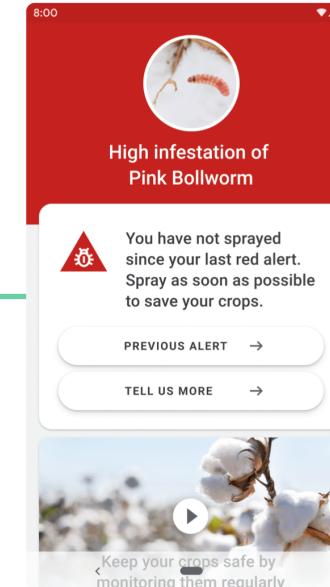
He then opens the app and captures 2 trap images.



The pests are detected and counted from the image uploaded.



An advisory is then generated on the app.



App Flow



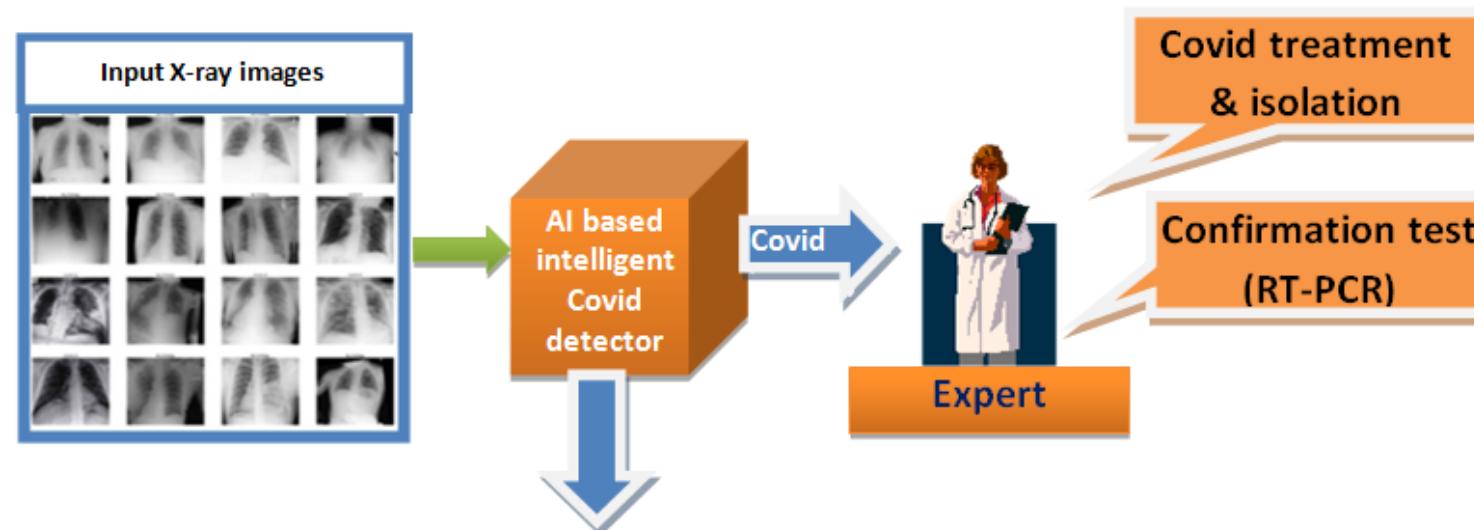
AI in Agriculture

- Pest control in cotton cultivation ([Wadhwani Foundation, Govt. of Telangana](#))
 - Mobile App. Based alert/prescription model (**CottonAce**)
- Crop productivity enhancement model ([NITI Aayog, IBM](#))
 - To provide real time advisory to farmers for increasing crop yield
 - Better yield, increased farmers' income



AI in Healthcare

- COVID-19 Prediction from X-ray([ATMAN AI by DRDO](#))
 - During peak of pandemic RTPCR test results were getting delayed by days
 - COVID could be predicted from X-rays by AI, Without RTPCR result
 - Fast treatment initiation; favourable outcome





AI in Agriculture

- Crop productivity enhancement model ([NITI Aayog, IBM](#))
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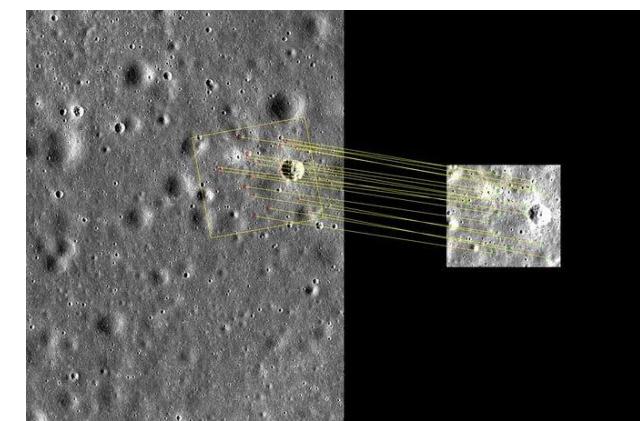


AI in Healthcare

- COVID-19 Prediction from X-ray([ATMAN AI by DRDO](#))
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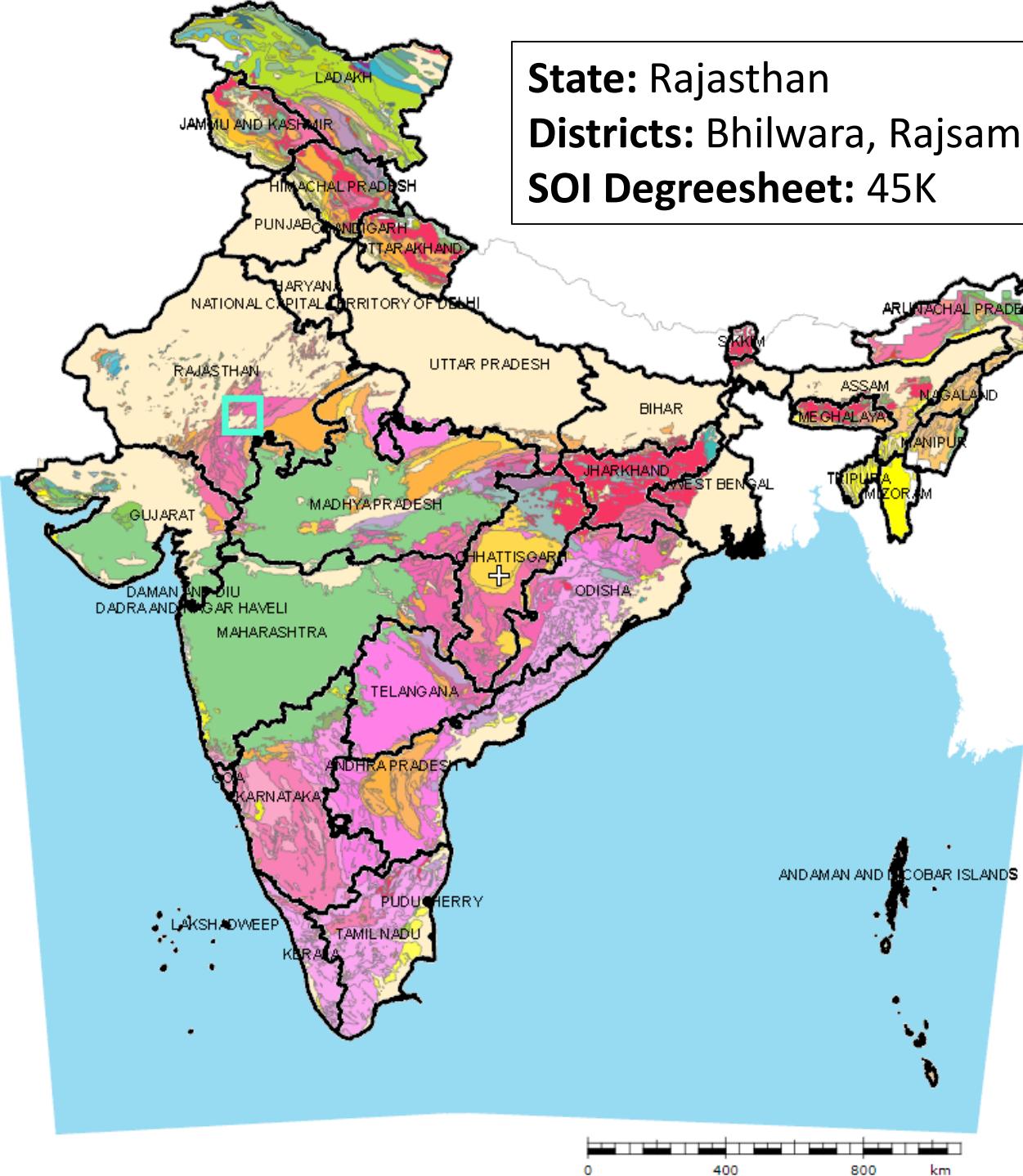
AI in Space Application

- Chandrayaan-3 soft landing ([ISRO, Academia](#))
 - Deciding safe landing spot through deep convolutional neural network
 - Camera of lander captures moon surface
 - AI studies the topography and decides





AI in GSI: Search for Mineral Deposit using ML/DL in Rajasthan

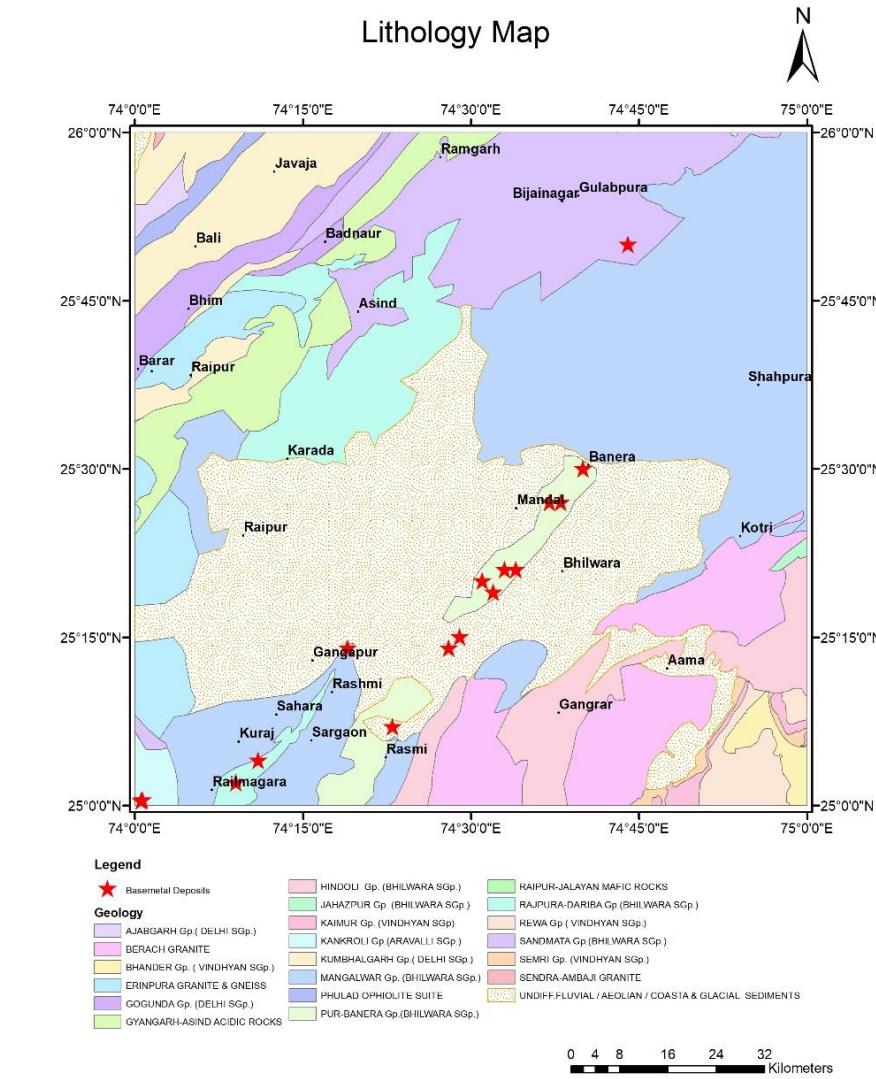


State: Rajasthan
Districts: Bhilwara, Rajsamand
SOI Degreesheet: 45K

Study Area & What is Known?



Lithology Map





ML Random Forest(RF)

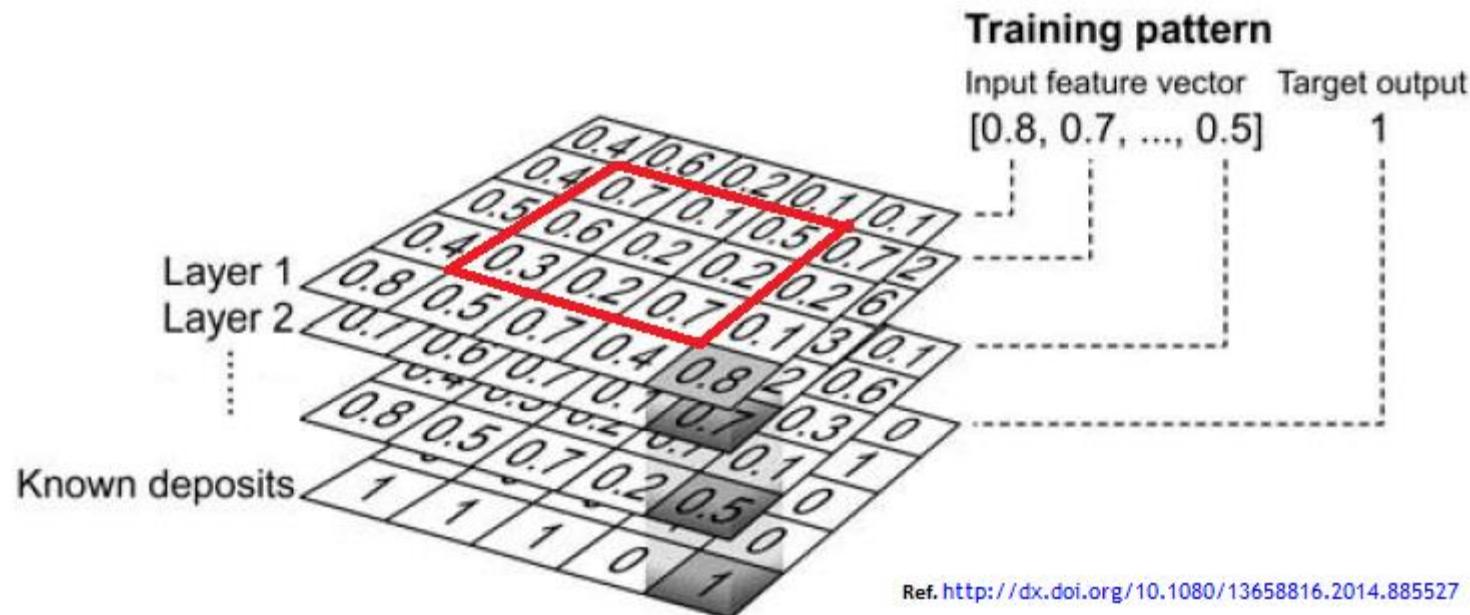
- Point Scanning Method (Grey shaded grid cell)



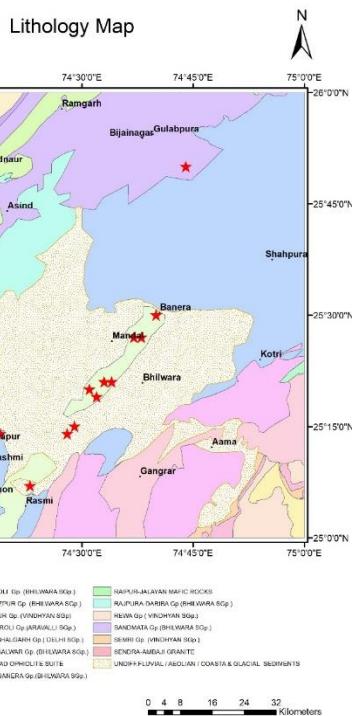
DL

Convolutional Neural Network (CNN)

- Window Scanning Method (Red window)



Lithology Map

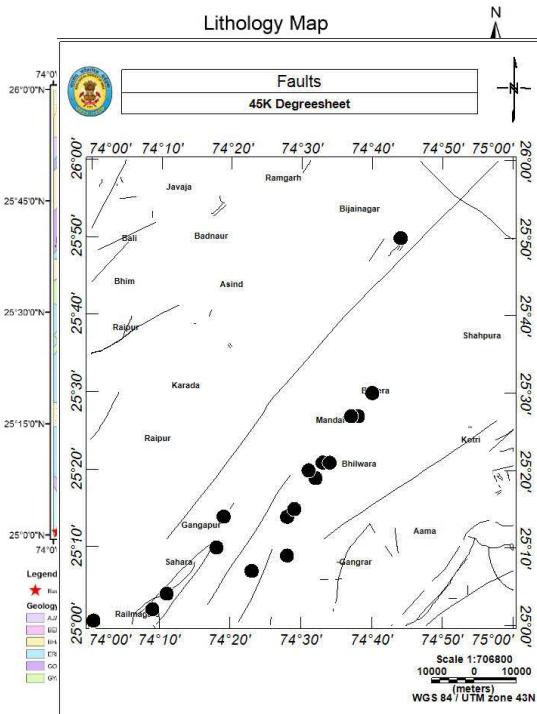


Input Data Layers

- Geology
 - Lithology



Lithology Map

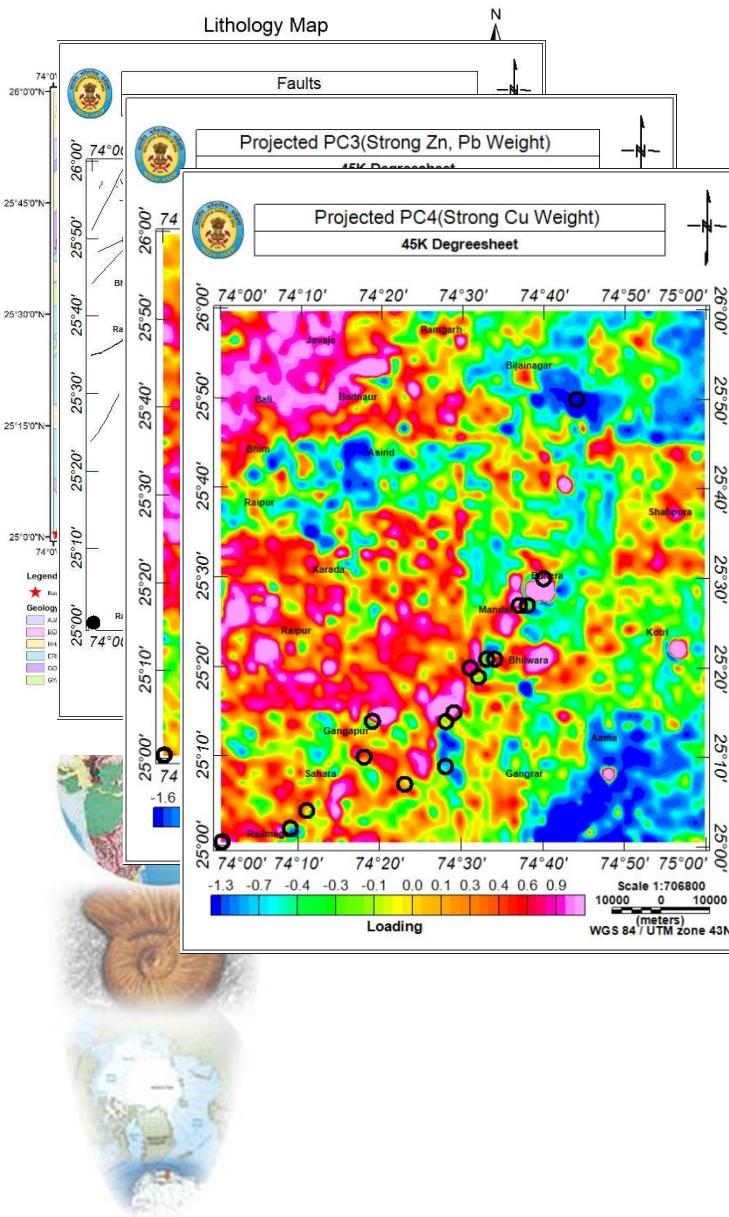


Input Data Layers

- Geology
 - Lithology
 - Fault

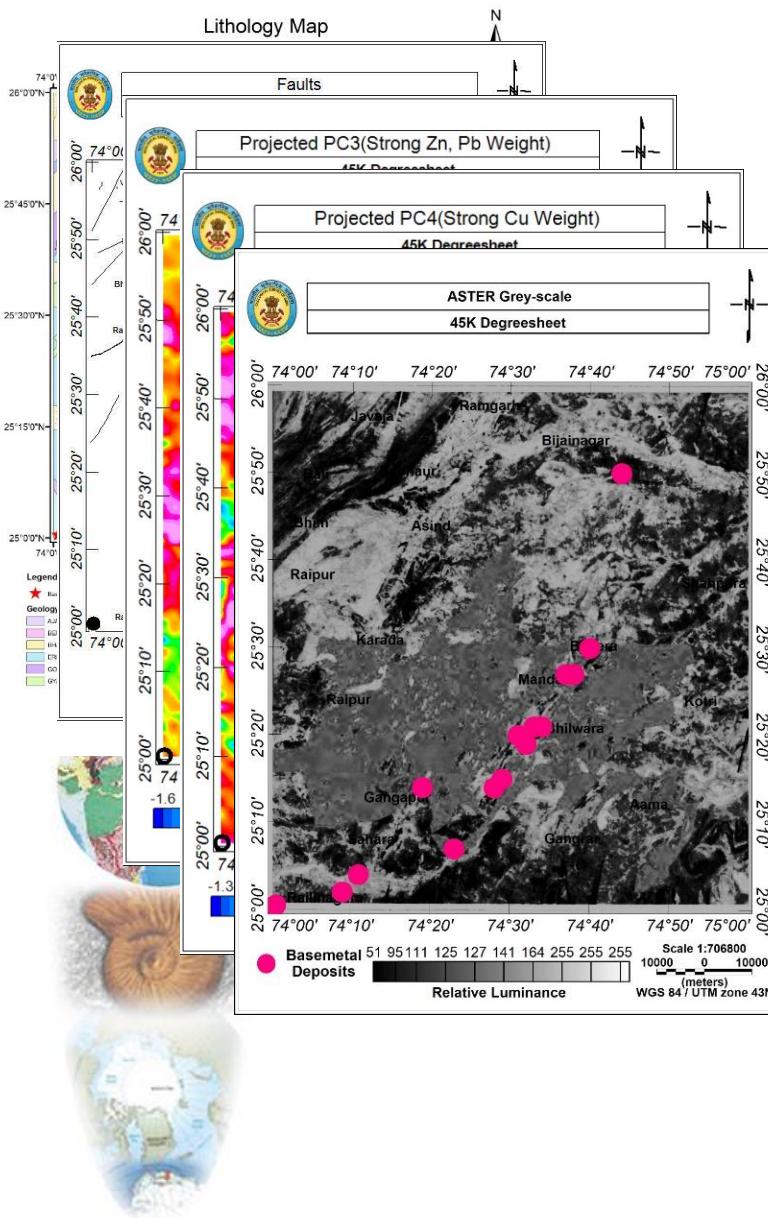


Input Data Layers

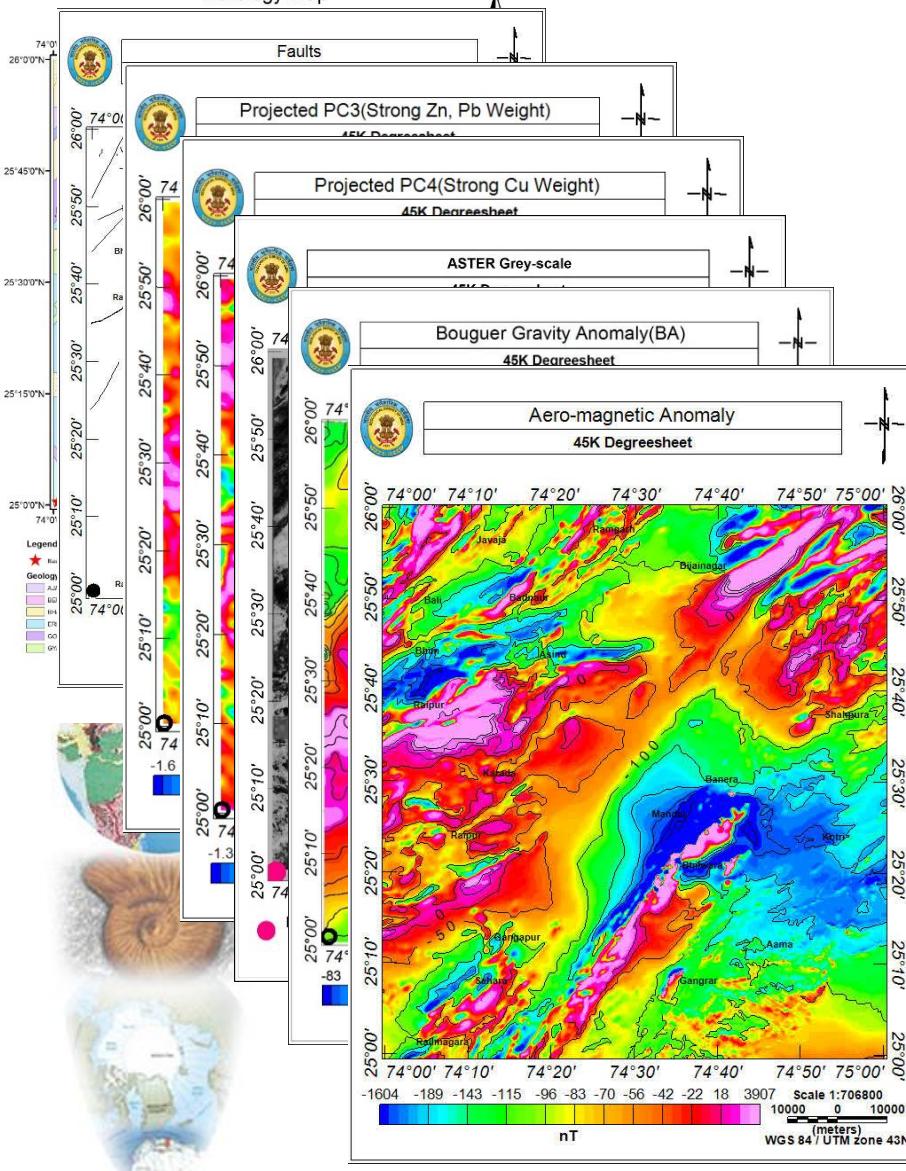


- **Geology**
 - Lithology
 - Fault
 - **Geochemistry (Stream Sediment)**
 - 3rd Principal Component (Pb, Zn)
 - 4th Principal Component (Cu)

Input Data Layers



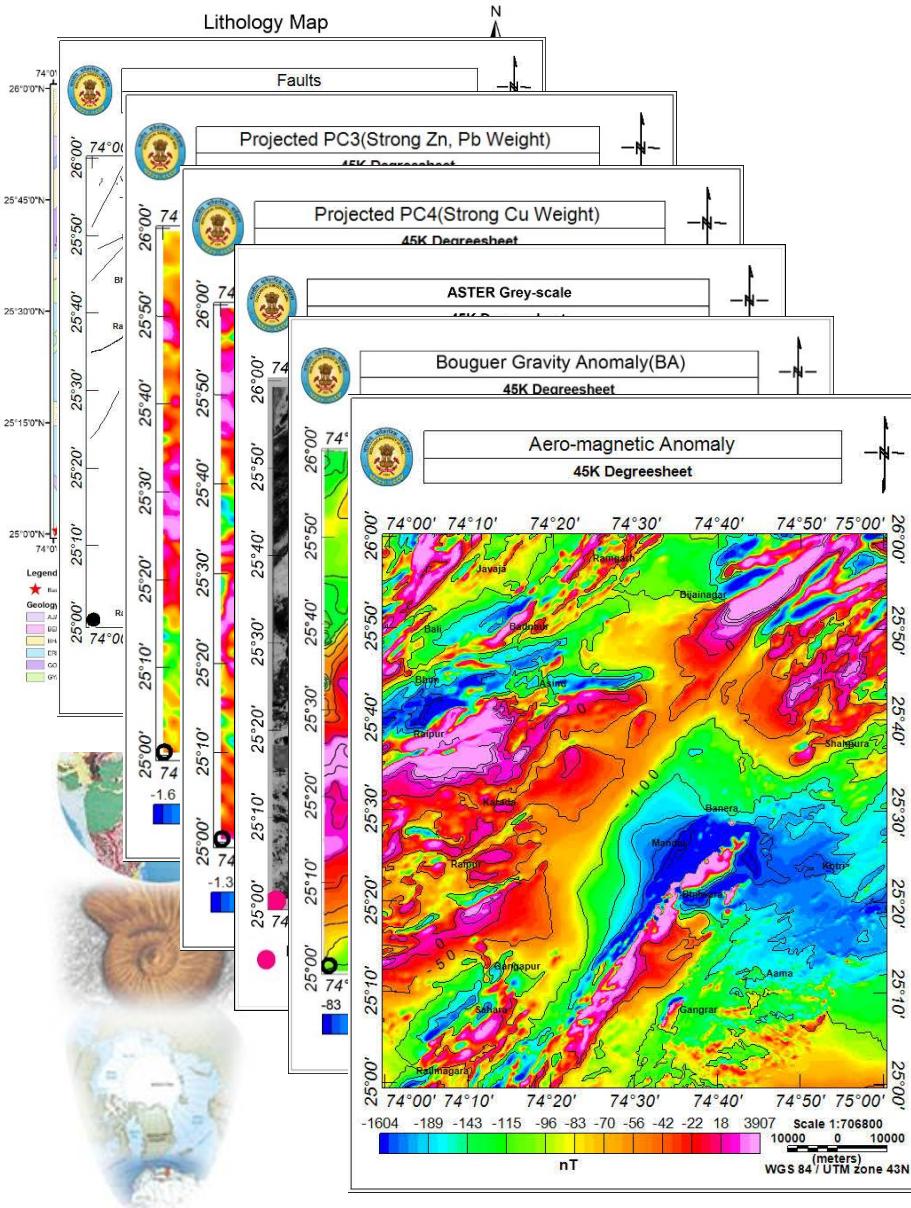
- **Geology**
 - Lithology
 - Fault
- **Geochemistry (Stream Sediment)**
 - 3rd Principal Component (Pb, Zn)
 - 4th Principal Component (Cu)
- **Remote Sensing (ASTER)**
 - ASTER greyscale map



Input Data Layers

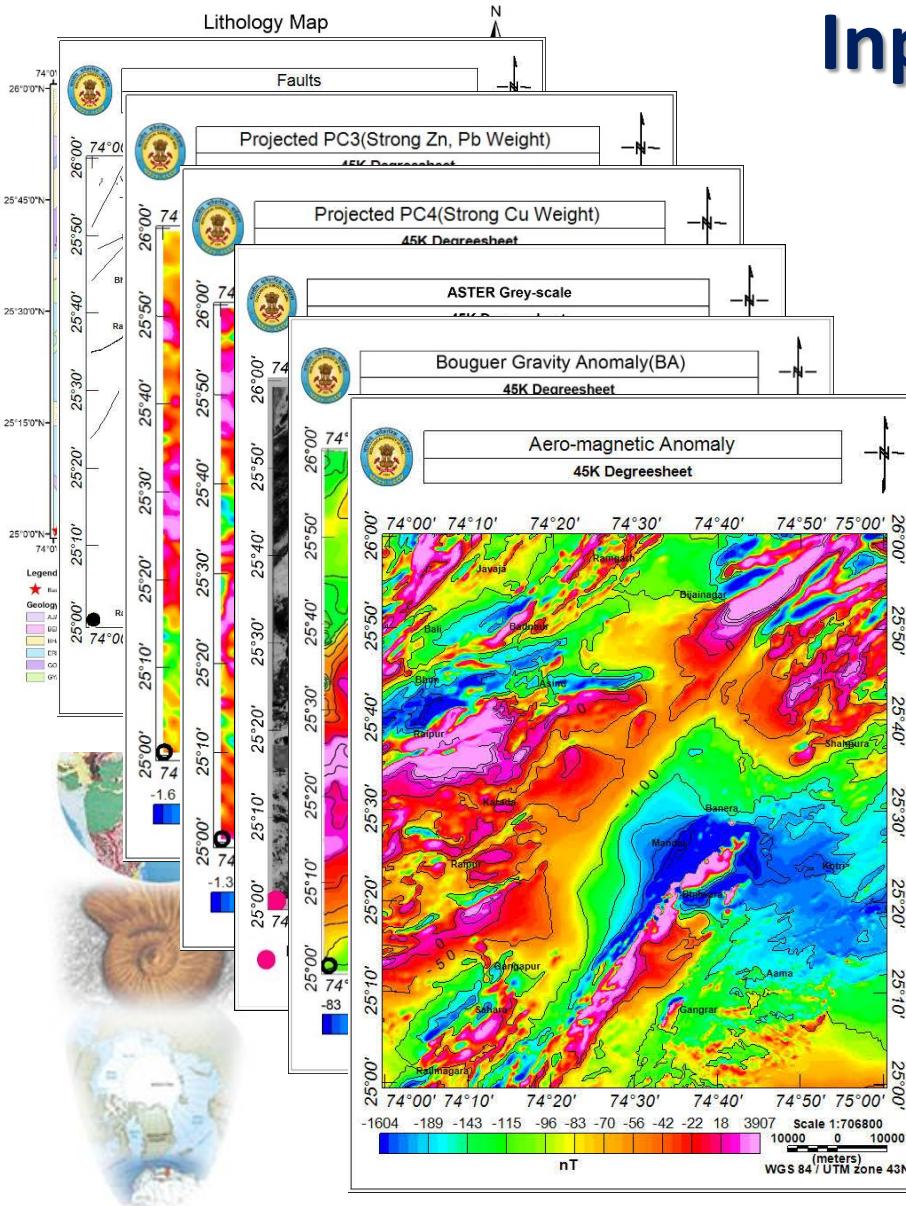
- **Geology**
 - Lithology
 - Fault
- **Geochemistry (Stream Sediment)**
 - 3rd Principal Component (Pb, Zn)
 - 4th Principal Component (Cu)
- **Remote Sensing (ASTER)**
 - ASTER greyscale map
- **Geophysics**
 - Gravity Anomaly
 - Magnetic Anomaly

All Input Data Layers (Total 19)

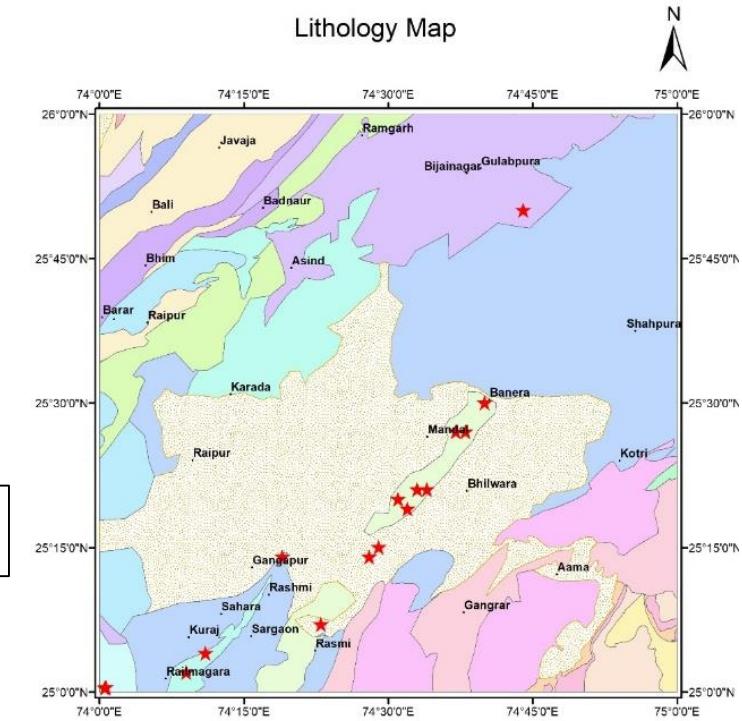


- **Geology**
 - Lithology
 - Fault
 - Lineament
 - **Geochemistry (Stream Sediment)**
 - 3rd Principal Component (Pb, Zn)
 - 4th Principal Component (Cu)
 - **Remote Sensing (ASTER)**
 - ASTER greyscale map
 - **Geophysics**
 - Gravity Anomaly
 - Magnetic Anomaly
 - Horizontal Derivative/Analytical Signal
 - 1st, 2nd vertical Derivatives
 - Tilt Derivatives
 - Gravity Euler Solution
 - Magnetic Lineament/porphyry centres

Input, Output & Methodology



Learn from Known Deposits

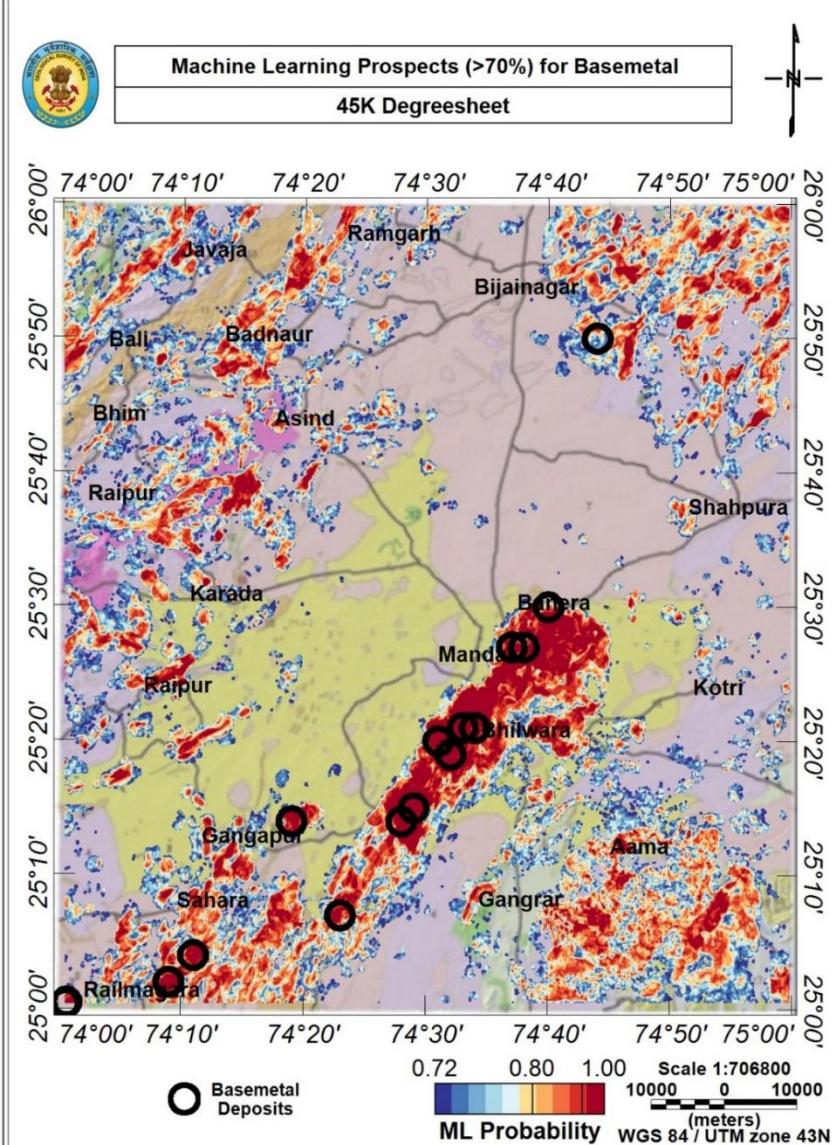


Predict Mineral Deposits at Nearby Areas

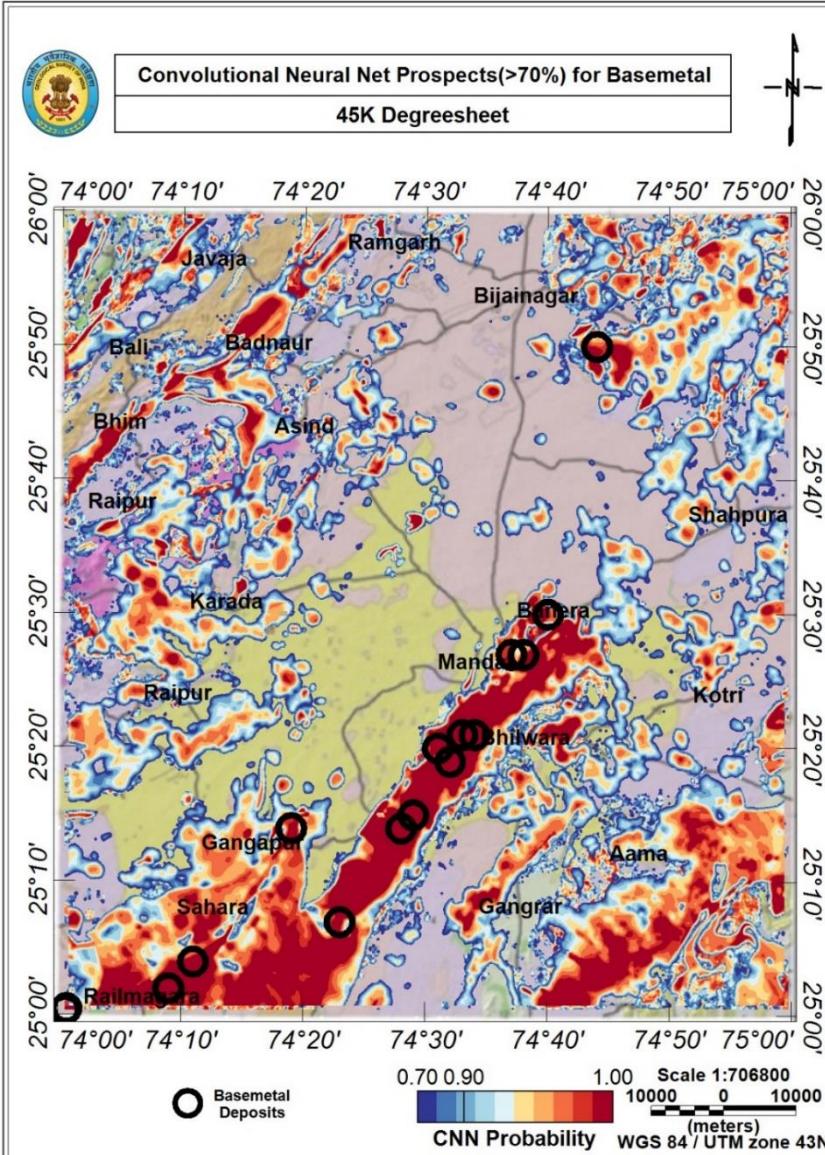


RESULTS

Random Forest Prediction



Deep Convolutional Neural Network Prediction



- **Training & Validation:** Known deposits are on high probable zones(>0.7). **Training is satisfactory**
- **Prediction(Entire Area):**
 - Zones predicted below sand cover
 - Likely extension of Aguchha mine predicted
 - **To be ground-checked**

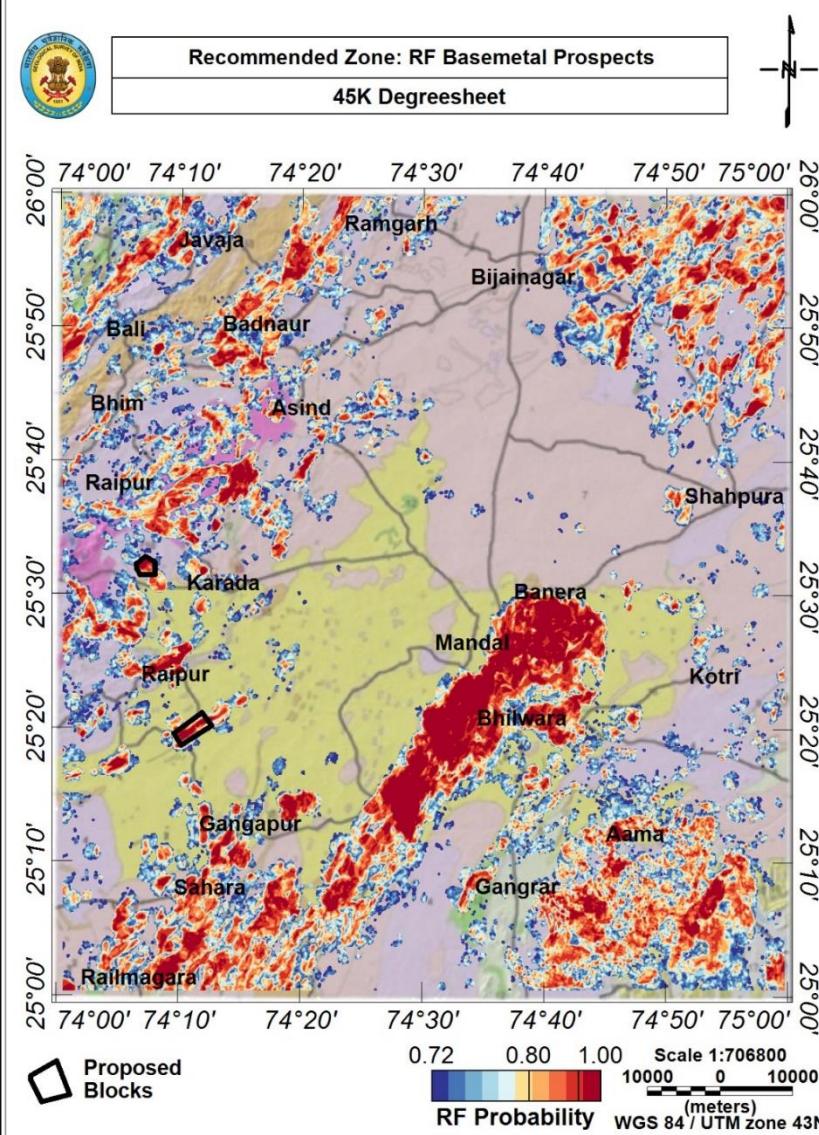
NOTE 1: Any algorithm predicts within [0,1] probability range. We assume anything >0.7(i.e. 70% chance) is a probable deposit. One may go for >80% or >90% threshold for prioritising most prospective zones.

NOTE 2: Mean Absolute error in computation (RF): 0.35
Mean Absolute error in computation (CNN): 0.09

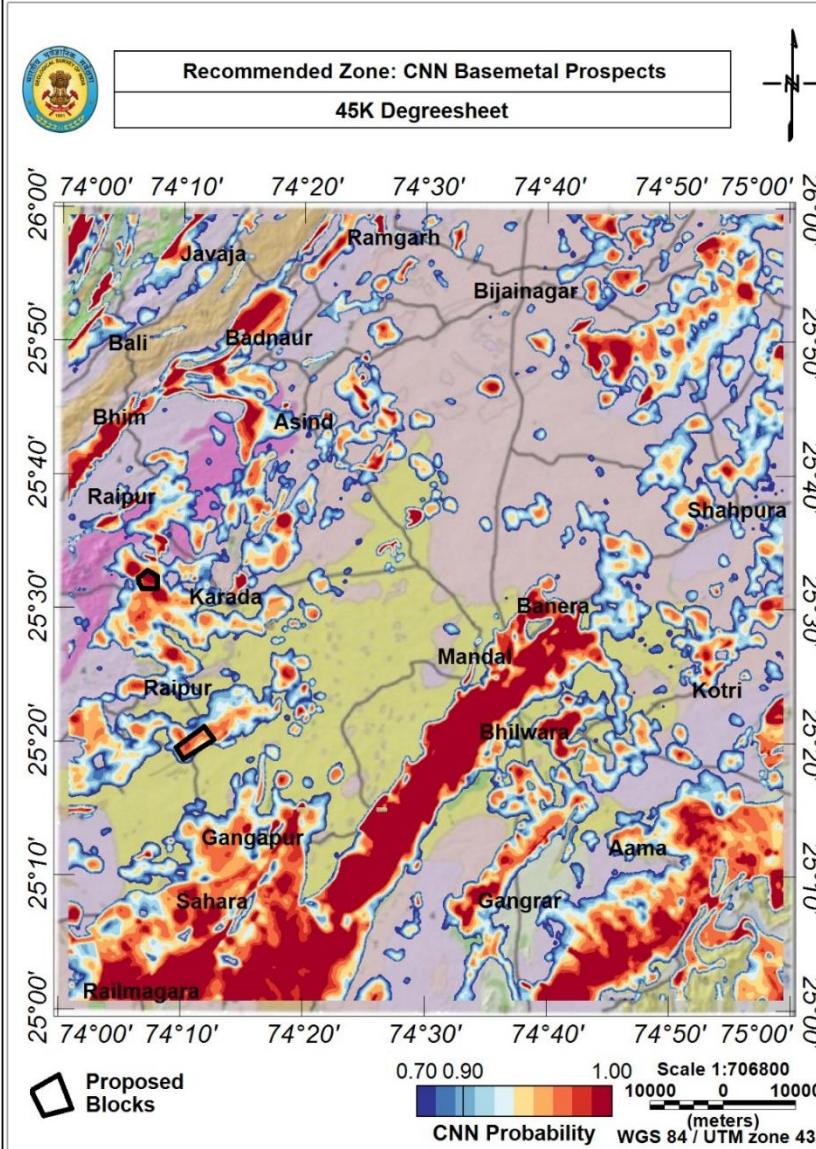


Recommendations & Follow Up

Random Forest Prediction



Deep Convolutional Neural Network Prediction



- **2 Blocks have been recommended where both RF and CNN has predicted high Basemetal probability**
- B1: SE of Raipur
- B2: West of Karada
- **Both the blocks are proposed to be investigated through detailed geophysical (MT, GM) surveys**
- **Boreholes to confirm basemetal potential**



Conclusion

- AI is the broader domain
 - ML is a subset of AI
 - DL is another subset of ML
- We have already been using AI/ML/DL in our daily lives but may not be aware of it
- In GSI, ML based Base-metal prospectivity analysis was carried out in Rajasthan using two ML and DL algorithms
 - Both Algorithms could learn and predict existing deposits (**Successful Training & validation for RF, CNN**)
 - **Two blocks have been recommended from predictions made by AI**
 - **Work in progress by GSI to validate the predictions**



Thank You

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