Road Network Extraction from Satellite Imagery

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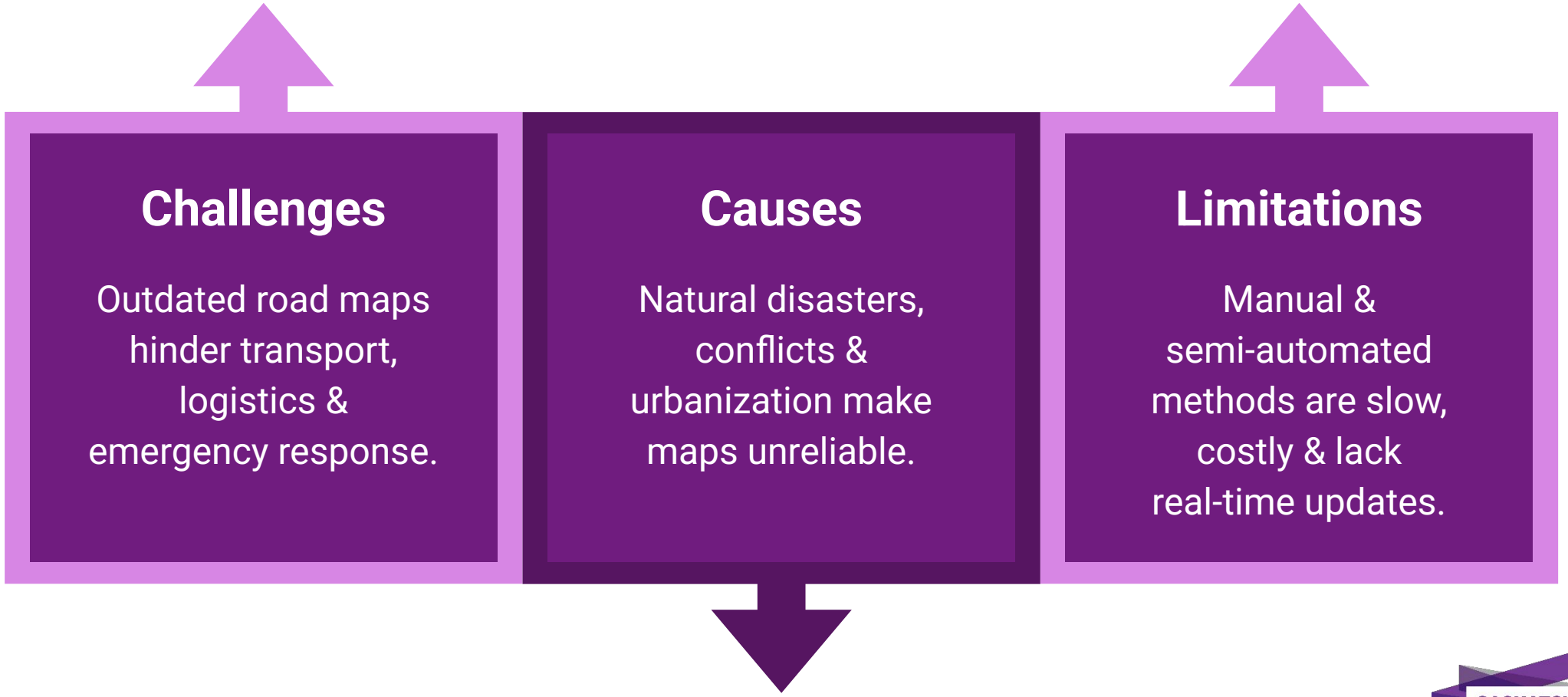
Agenda

- Problem Statement
- Objectives
- Project Methodology
- Architecture Diagram
- Project Timeline
- Key Deliverables
- Scope of Future Work
- Conclusion
- References

Problem Statement



Objectives

Develop a deep learning model for high-accuracy road extraction from satellite imagery.

01	**Efficiency**	• Automate road mapping to reduce processing time by at least 50% compared to manual methods.
02	**Accuracy**	• Achieve >90% precision in road detection, minimizing false positives/negatives.
03	**Scalability**	• Develop an open-source model adaptable for various terrains and satellite data sources.
04	**Real-World App**	• Support disaster management, infrastructure planning & navigation with real-time updates.
05	**Reliability**	• Ensure consistent and up-to-date road maps for crisis-affected regions.

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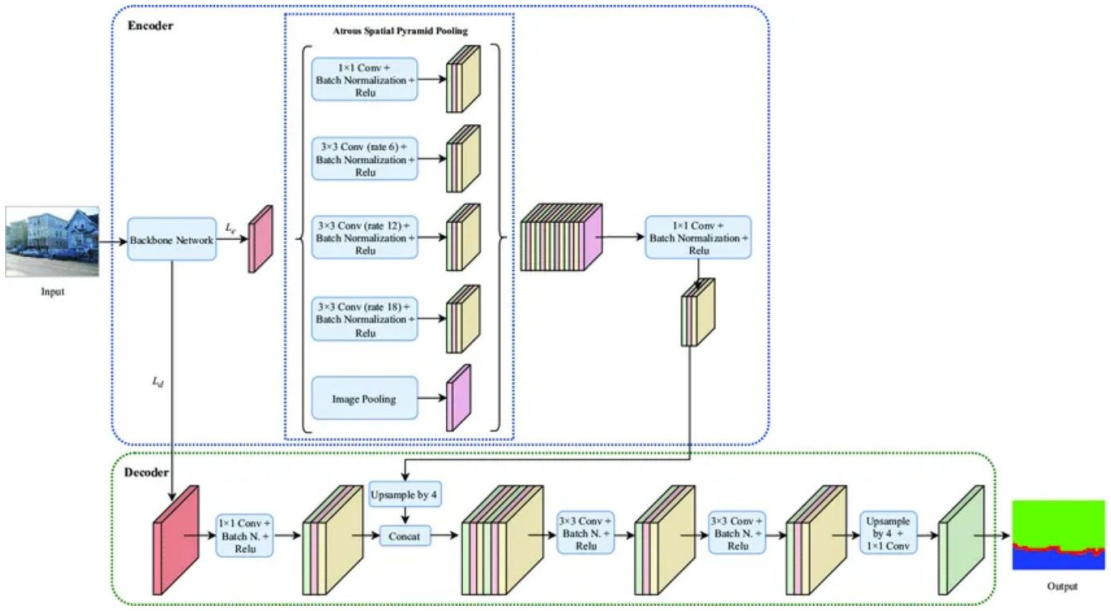
Project Methodology (1/2)

- **Dataset:** Kaggle, containing high-resolution satellite images with road network annotations (https://www.kaggle.com/datasets/balraj98/deepglobe-road-extraction-dataset/data).
- **Processing:** Resize, Normalization, Augmentation, Noise Reduction.
- **Model Selection:** DeepLabV3+.

Criteria	SegNet	DeepLabV3+	U-Net
Accuracy	★★★	★★★★★	★★★★
Training Speed	★★★★	★★★	★★★★
Memory Efficiency	★★★★★	★★★	★★★★
Handles Complex Road Networks	★★	★★★★★	★★★★
Best for Small Roads & Occlusions	★★	★★★★★	★★★



DeepLabV3+ Architecture

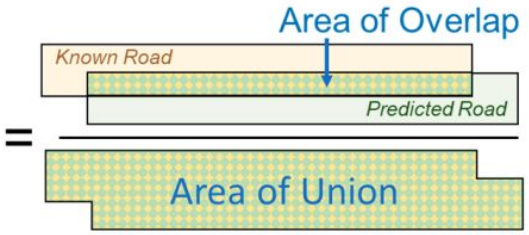
Project Methodology (2/2)

- **Framework:** PyTorch.
- **Libraries**: Torchvision, OpenCV, NumPy, Pandas, Matplotlib, Scikit-learn.

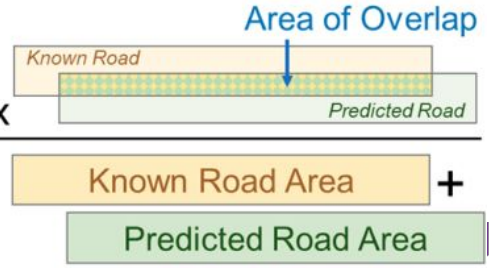
Step	PyTorch	TensorFlow
Pre-Trained Model	✅ Yes	✅ Yes
Custom Training	✅ Yes	✅ Yes
Flexibility	✅ Better	❌ Less Flexible
Deployment (Edge, Mobile, Web)	❌ Limited	✅ Better

- **Training and Evaluation:** Trained using a labeled dataset and evaluated using metrics (Intersection over Union, F1-Score).
- **Deployment:** Flask/FastAPI, Docker, TorchScript.

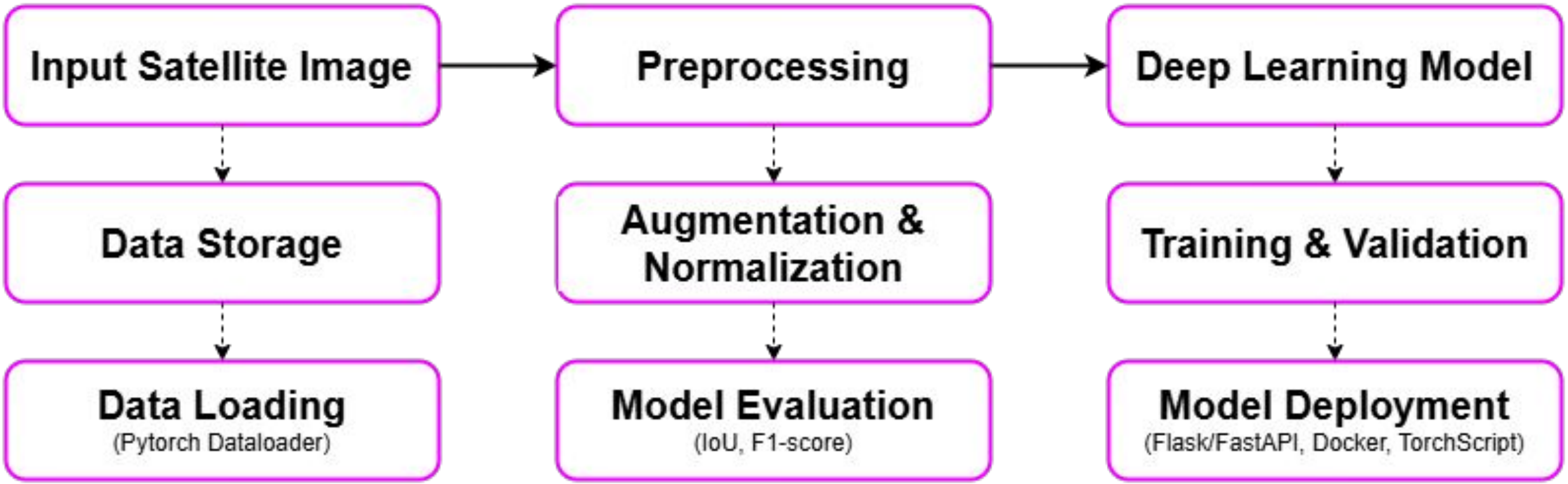
$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}} = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$



$$F1\ Score = \frac{\text{Area of Overlap} \times 2}{\text{Total Area}} = \frac{2x}{\text{Known Road Area} + \text{Predicted Road Area}}$$



Architecture Diagram



Project Timeline

Project Planning and Data Collection

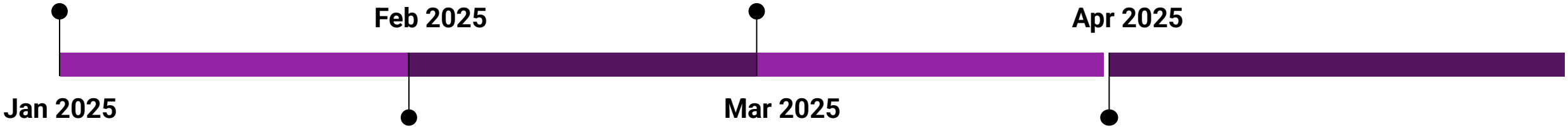
- Research and finalize topic with suitable datasets
- Define project goals, scope, & success metrics
- Prepare high level proposal & presentation
- Set up the development environment

Model Optimization/Improvement

- Analyze baseline performance to optimize & improve model
- Implement, train and evaluate the optimized/improved model
- Compare results among the baseline & optimized/improved model

Validation, Testing

- Perform cross-validation to ensure model robustness
- Test the model on the test set & compute final metrics
- Visualize predictions, analyze failure cases & identify potential improvements



Data Preprocessing and Exploration

- Load and explore the dataset (Visualize satellite images & road mask)
- Preprocess the data (Resize, normalize, split data)
- Augment the dataset (Rotation, flipping, cropping)

Model Selection and Baseline Development

- Select model and implement a baseline model
- Train and evaluate the baseline model

Deployment

- Convert the trained model to a deployable format
- Develop a simple pipeline for inference & test

Finalization and Documentation

- Prepare a detailed project report & presentation
- Conclude the project with programming codes & reports

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Conclusion

- This project aims to develop a deep learning model using DeepLabV3+ for accurate road network extraction from satellite imagery.
- We have outlined a structured methodology, including dataset preprocessing, model training, and evaluation.
- The expected outcome is an efficient and scalable solution for automated road mapping, benefiting urban planning and navigation.
- Future work will focus on model optimization, real-world testing, and integrating pathfinding algorithms like Dijkstra's for enhanced functionality.

References (1/2)

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