Integrated Classification and Localization of Targets using Bayesian Framework in Automotive Radar

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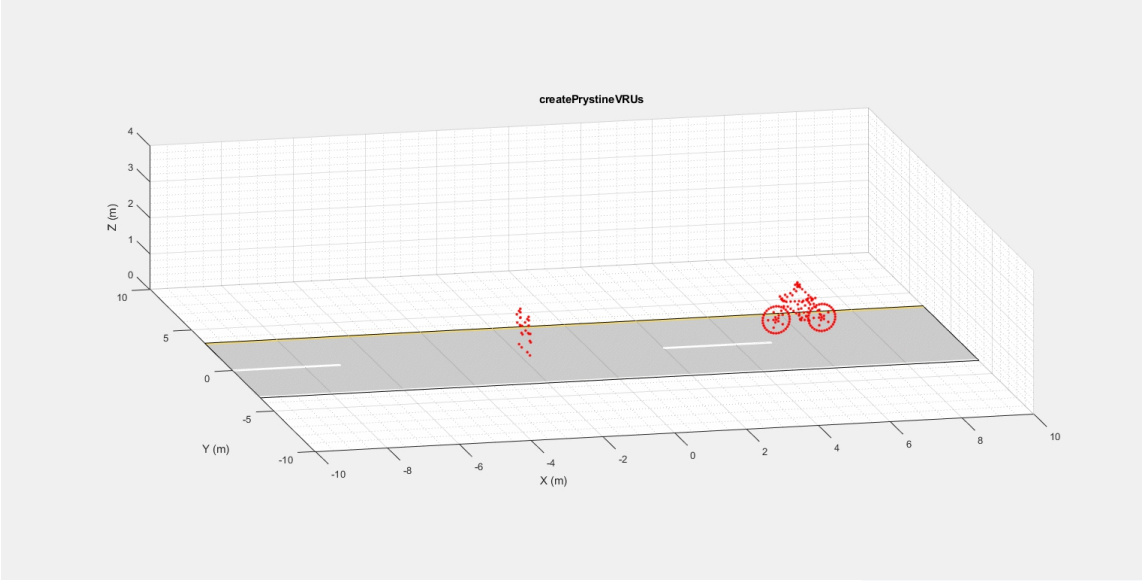
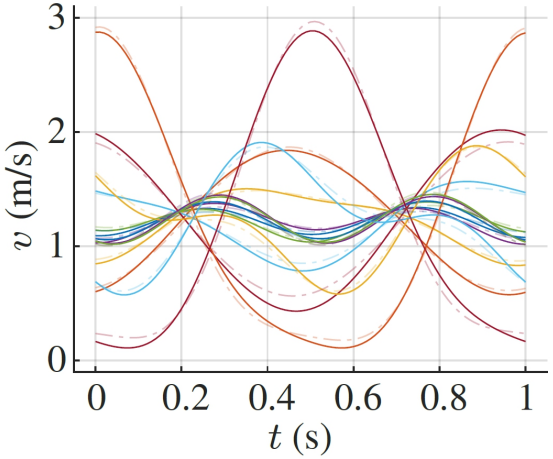
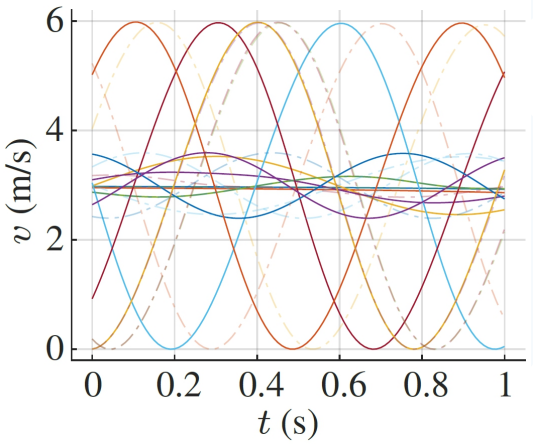
Content

- Problem Statement
- Contribution
- Results
- Conclusion

Problem Statement (1/2) – Feature Similarity







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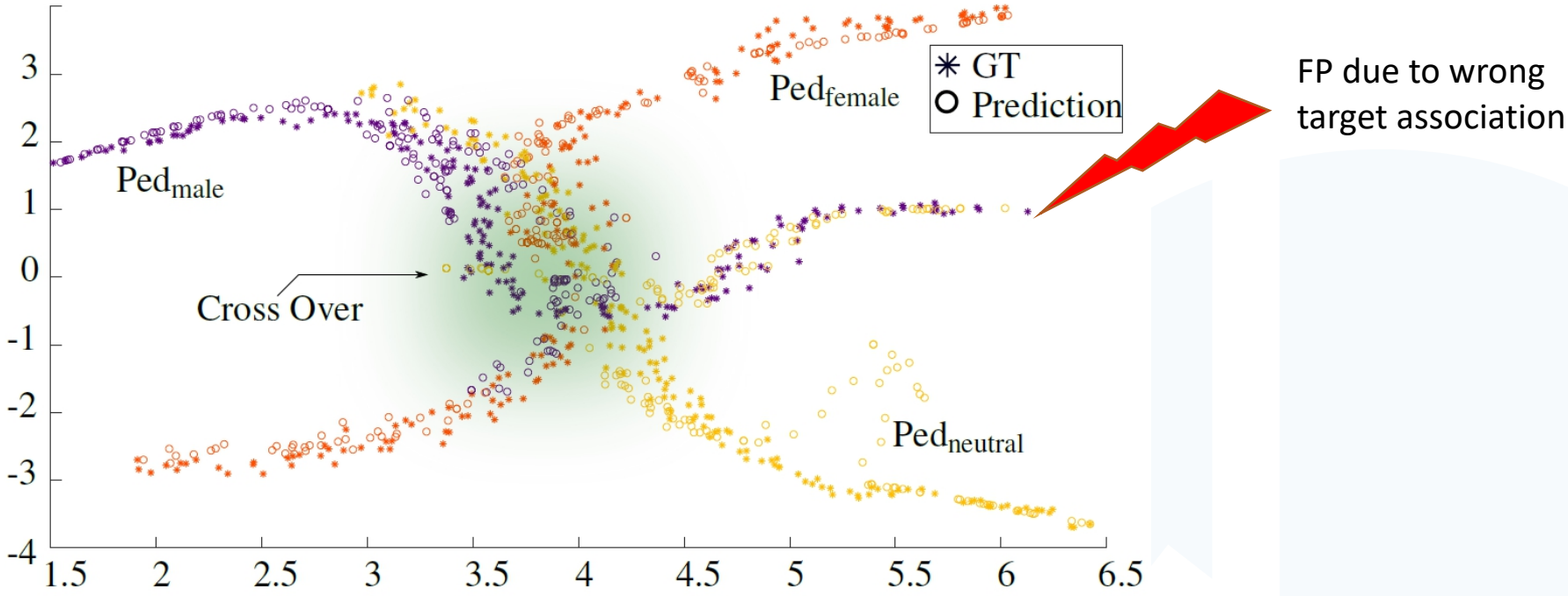
Problem Statement (2/2) – Conventional Tracker



FP due to wrong target association

Problem

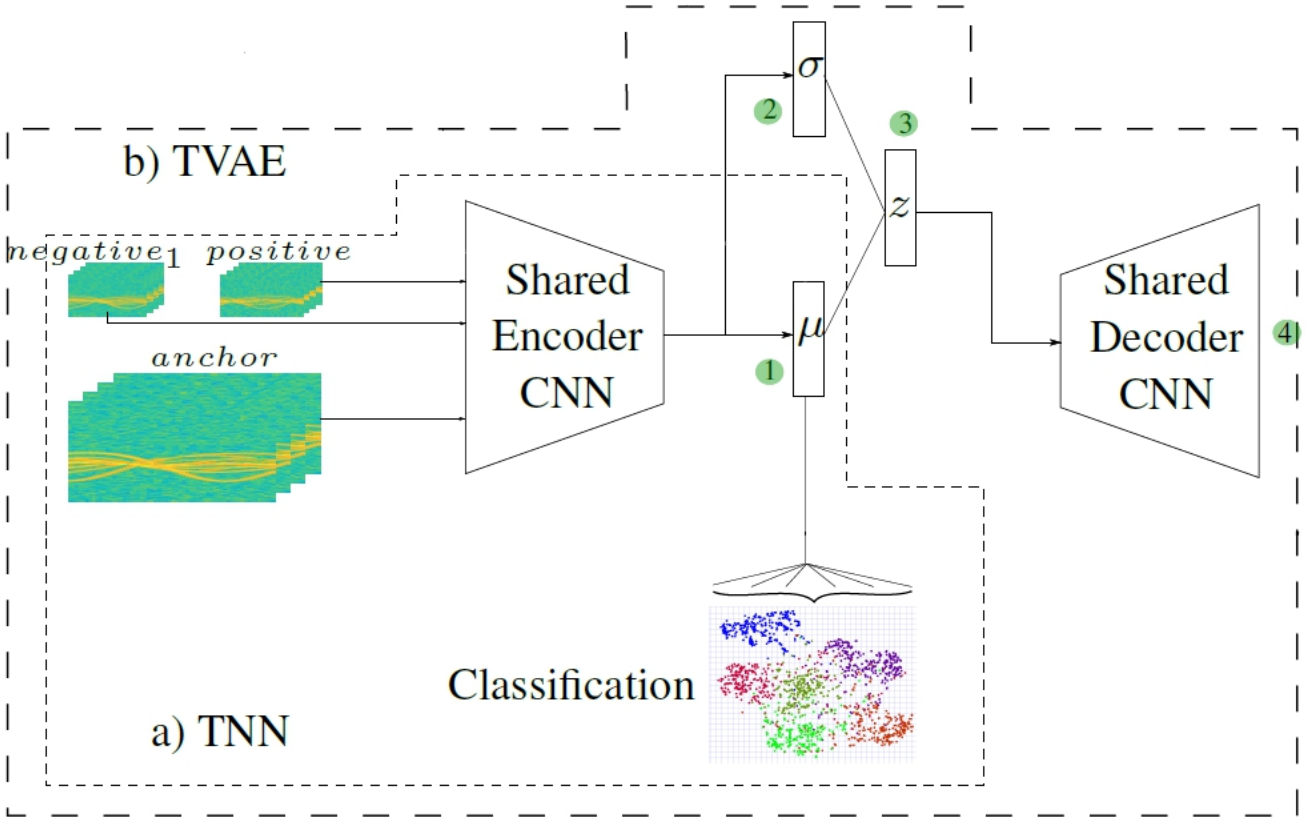
- Target Association
- Target Classification

Contribution

- ✓ Augmented State Vector + Bayesian Gating
- ✓ Feature tracking

Bayesian Integrated Framework (1/2)

Deep Metric Learning + VAE – Training (1/2)

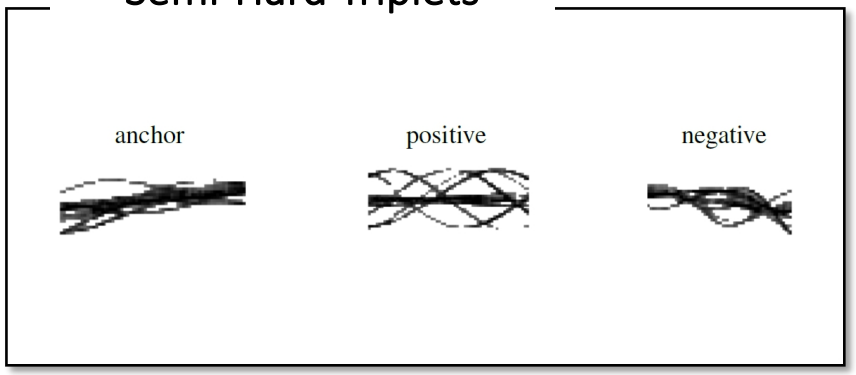


Bayesian Integrated Framework (1/2)

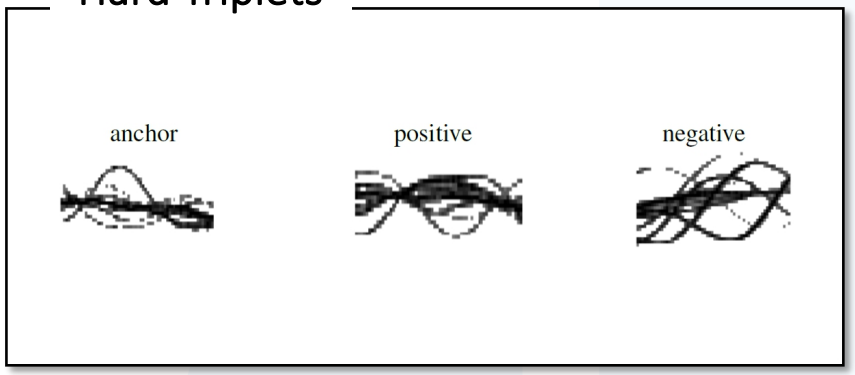
Deep Metric Learning + VAE – Training (2/2)

1) Online Triplet Mining

Semi-Hard Triplets



Hard Triplets

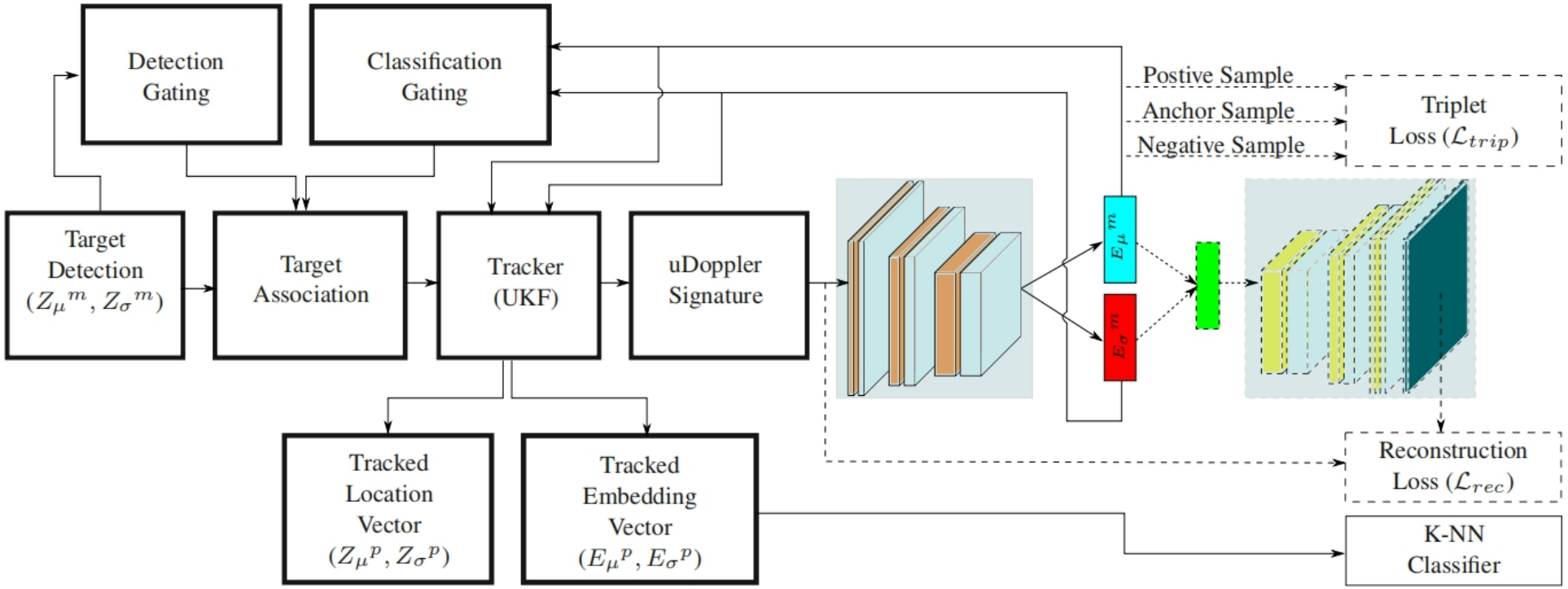


2) Loss function :

$$\mathcal{L}_{\text{TVAE}} = \alpha * \mathcal{L}_{\text{reconstruction}} + (1 - \alpha) * (\mathcal{L}_{\text{KL}} + \mathcal{L}_{\text{triplet}})$$

Bayesian Integrated Framework (2/2)

Augmented Bayesian Tracker – Inference (1/2)



Bayesian Integrated Framework (2/2)

Integrated Bayesian Tracker – Inference (2/2)

1. Augmented State Vector

$$x_a = \begin{bmatrix} px & py & v & Az & \mu_{11} & \mu_{12} & \cdots & \mu_{1M} \end{bmatrix}^T$$

$$g(x_a) = \begin{bmatrix} px^P & py^P & v^P & Az^P & {\mu_{11}}^P & \cdots & {\mu_{1M}}^P \end{bmatrix}^T$$

2. Gating

$$d_{det} = (z^p - z^m) S_{det}^{-1} (z^p - z^m)^T$$

$$d_{cls} = (E^p - E^m) S_{cls}^{-1} (E^P - E^m)^T$$

Results (1/2) – Classification Accuracy

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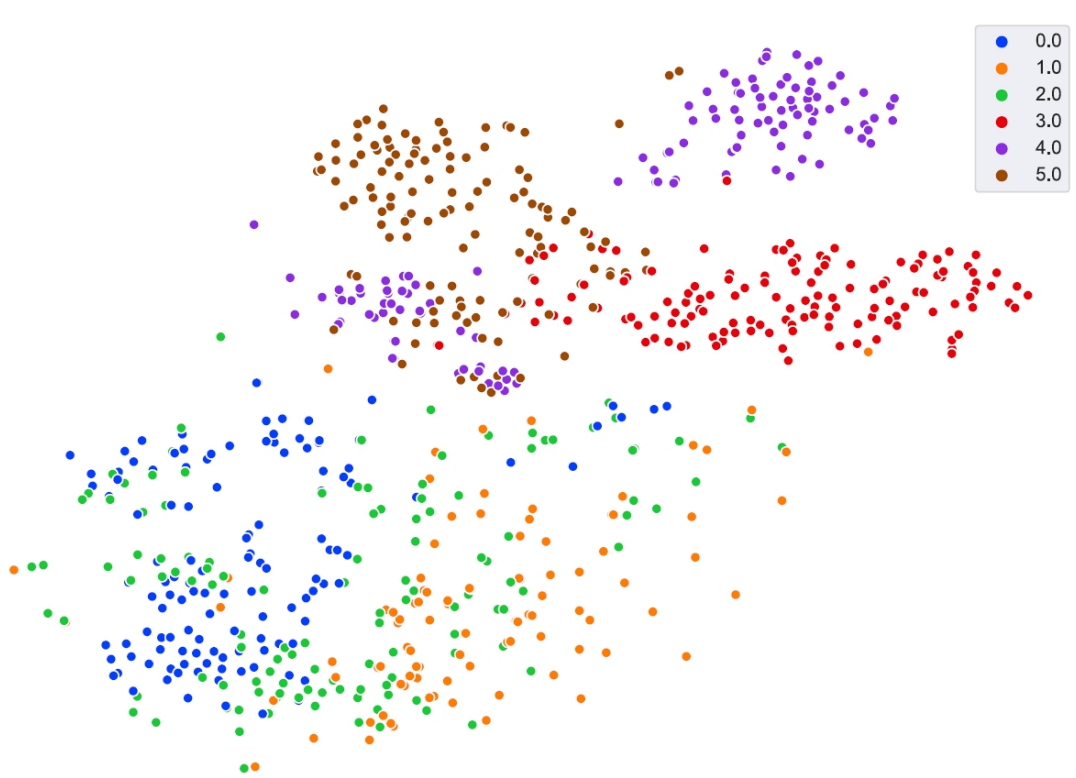
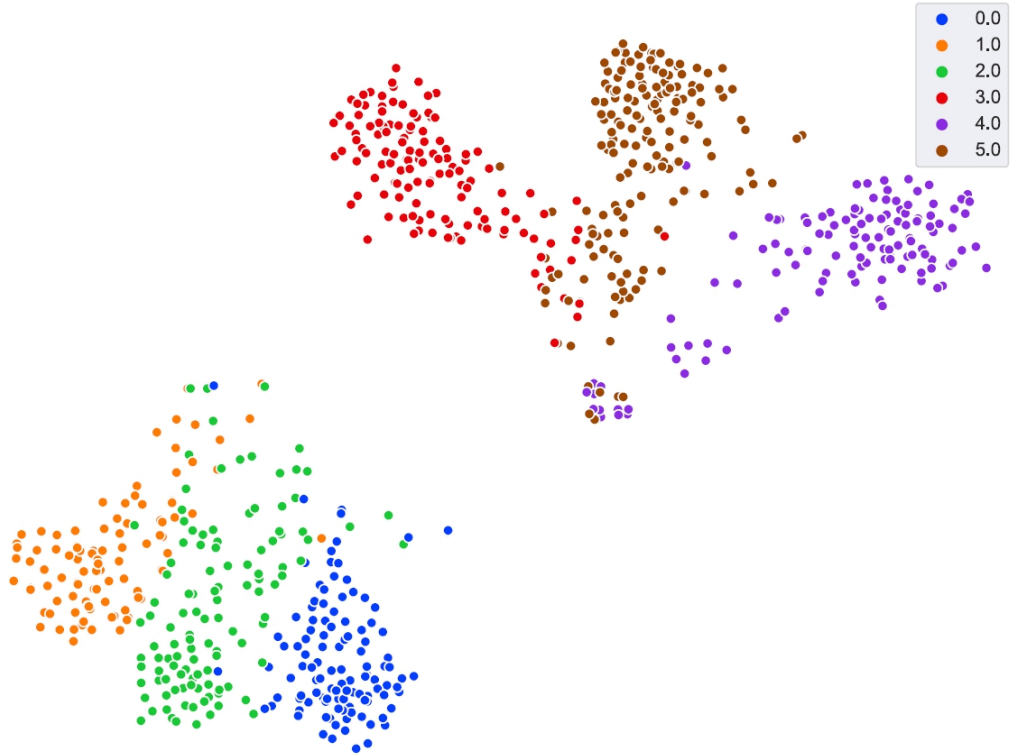


Accuracy = 75.56 %



Accuracy = 98.1 %

0 – female; 1 – male; 2 – teen; 3 – cycle1; 4 – cycle2; 5 – cycle3

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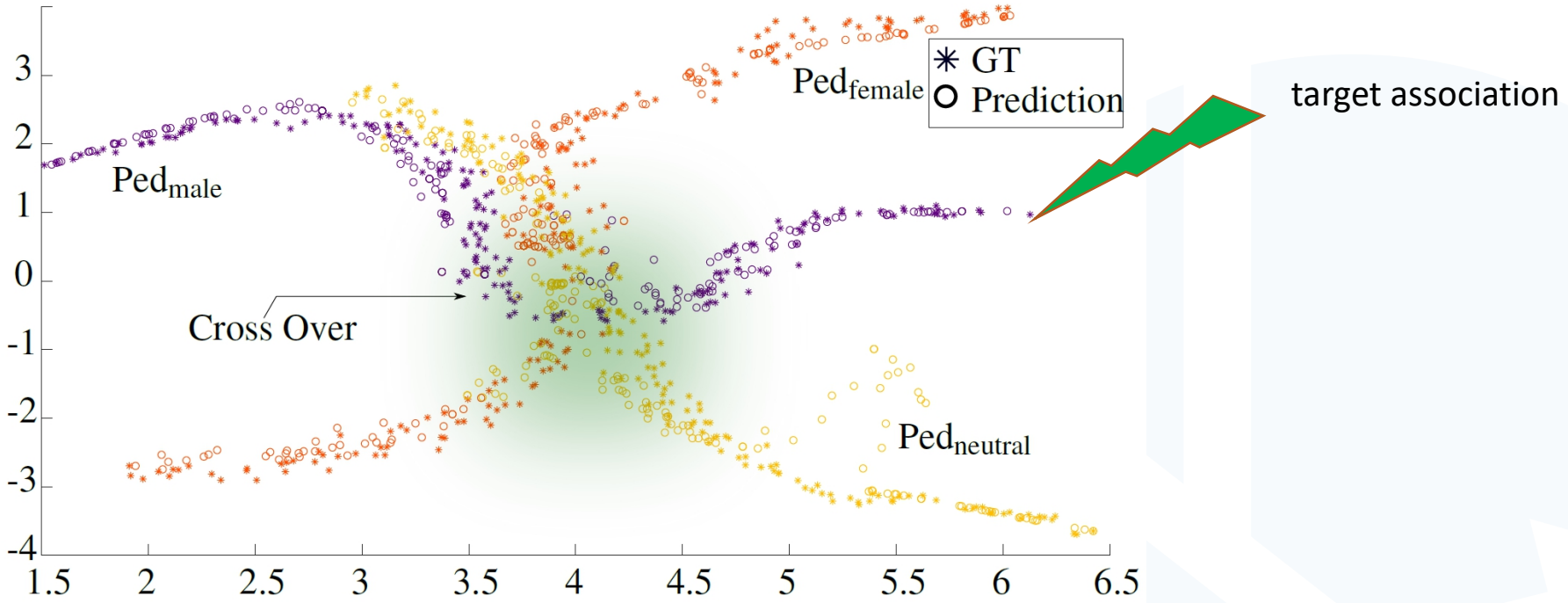
Results (1/2) – Tracking Association



Summary

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Conclusion

- ✓ Target Association
- ✓ Integrated Target Classification

Future Work

- ❑ Uncertainty Analysis
- ❑ Distance Learning between feature embedding

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