“A Transformer-Driven Approach for Associating AIS Tracks with Sentinel-2 Ship Detections”

By Erik Galler
Supervisor Hongchao Fan

Who Am I?

- Master from NTNU in Engineering and ICT
- Specialization in Geomatics and Deep Learning
- Winner of NIFRO prize, best space related Master's Thesis
- Winner of Geoforum's best geomatic Master's thesis
- Working in Microsoft, working on improving Coilot Agent

Improve tracking of vessels and identify those engaged in illicit activities

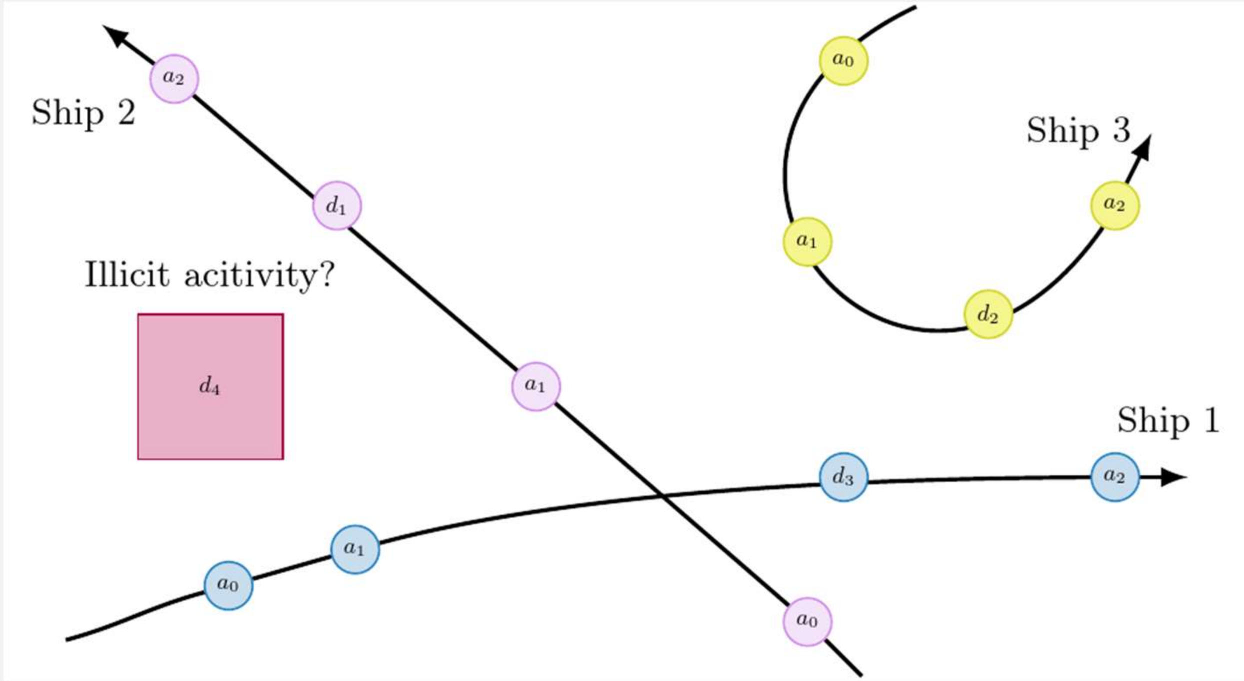
VAKE


How to track these vessels?

AIS tracks and Sentinel-2 detections

- **Automatic Identification System**
  - Mandated to transmit
  - Identifies vessel
  - Position, speed, course, etc.
  - Every 30 seconds to 3 minutes
  - Can be turned off

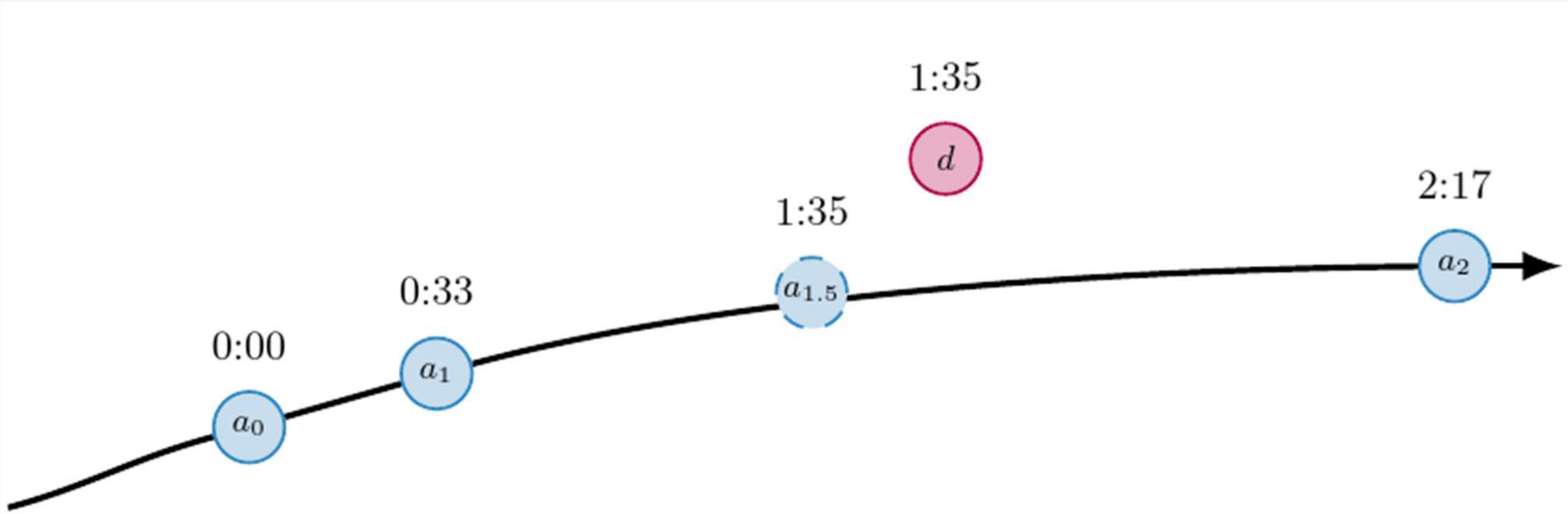
- **Sentinel-2 Satellite Imagery**
  - VAKE detects vessel using ML
  - Does not identify vessel
  - Position, course, size, etc.
  - Every 5 days
  - Can not be turned off



Traditional 2-Step Association

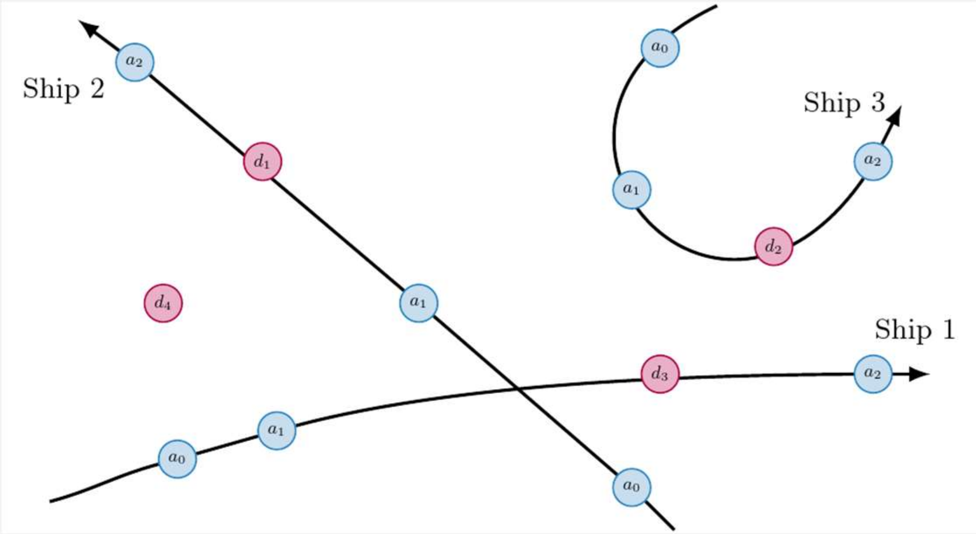
Step 1: Detection interpolation/prediction

Step 2: Match interpolated AIS with detection



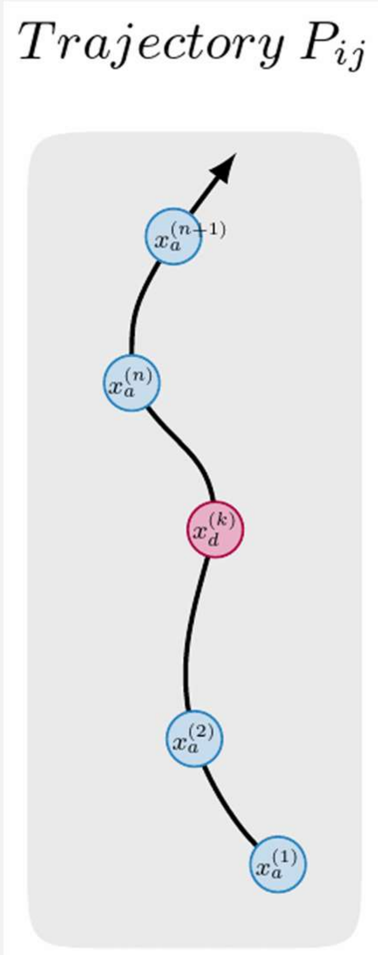
The Issue? Missing Context

- Does not use the actual detection
- What about the other trajectories and detections?
- Solves location prediction, not matching
- Outputs hard decisions, not probabilistic confidence

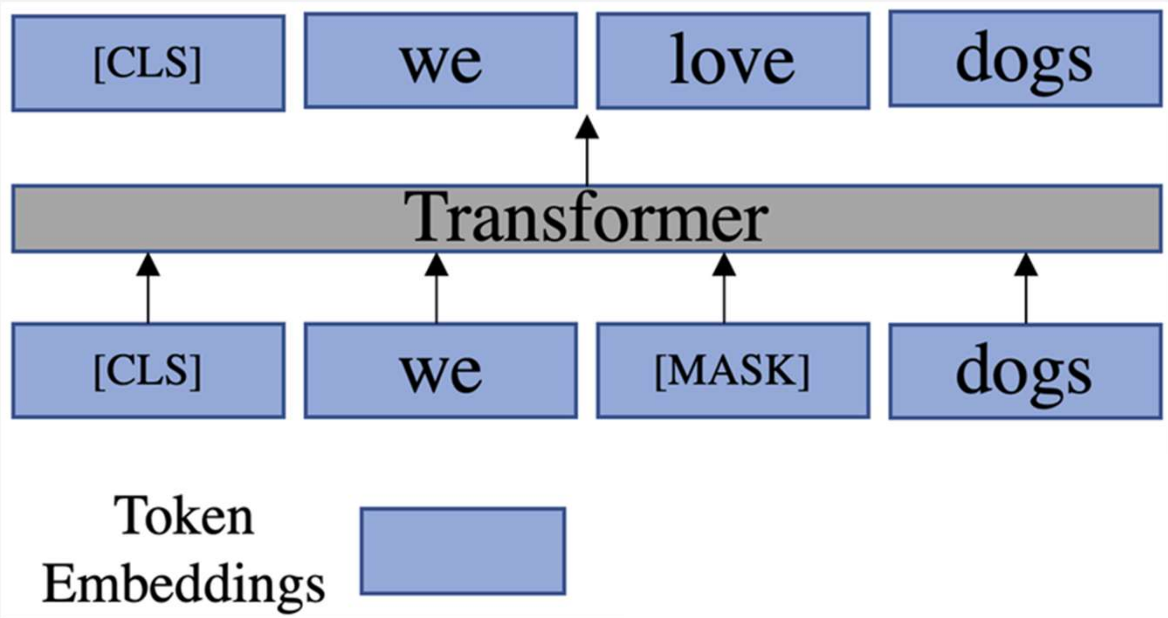


Trajectory Feasibility

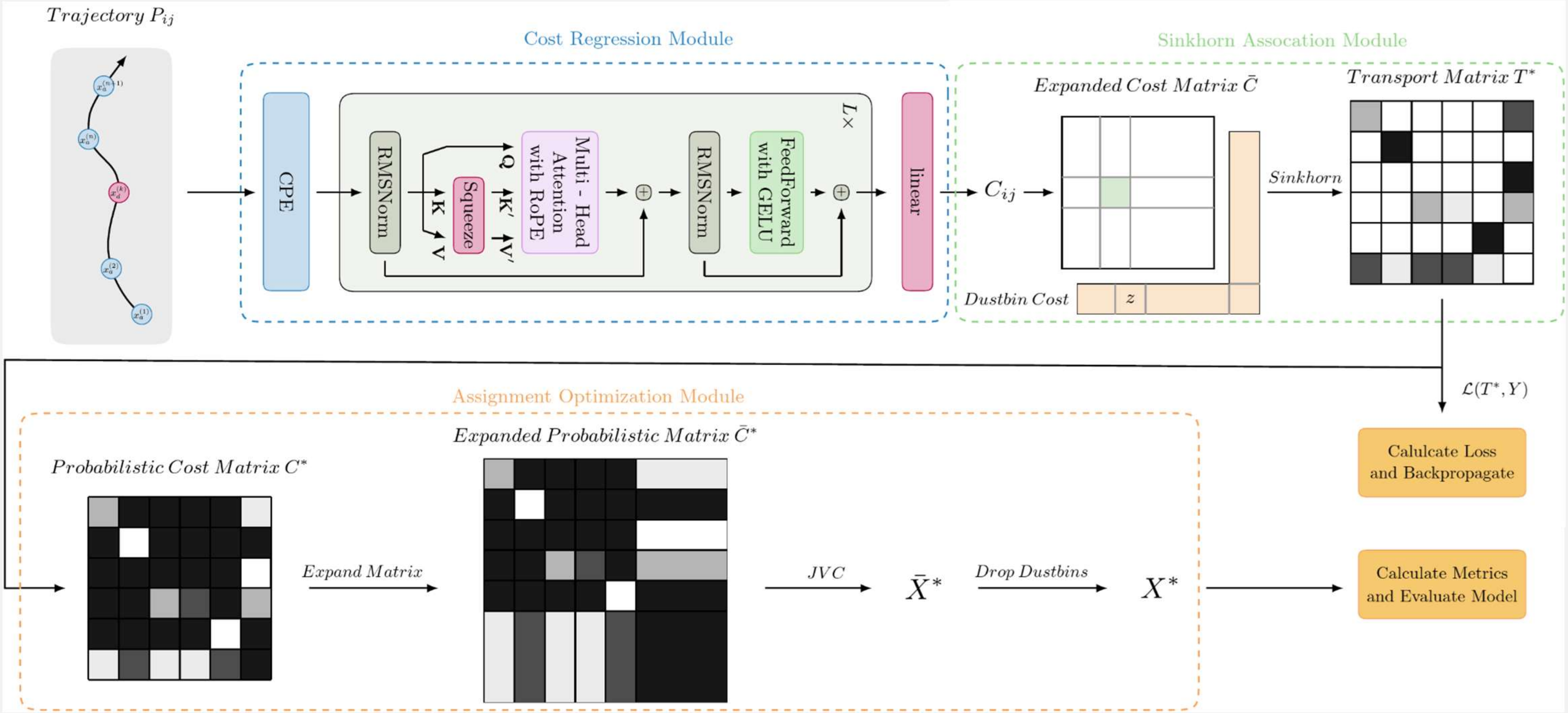
- Merge ship detection with AIS track
- Reformulate the question:
  - “How feasible is this trajectory?”
- Fits well with the Transformer architecture



Text Analogy

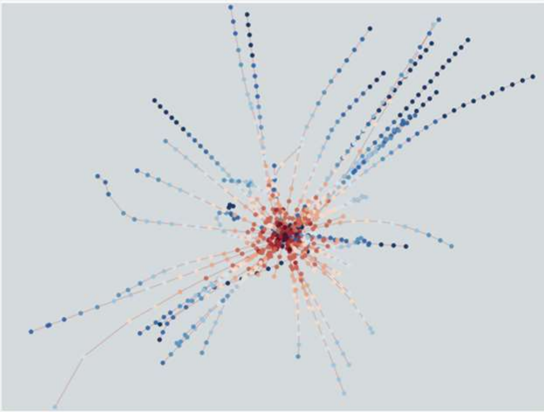


The A-TrajFormer Model



Capabilities and Results

- End-to-end fully learnable
- Holistically considers all detections and AIS tracks
- Interpretable probabilistic predictions
- Highly generalizable
- Handles spatial-temporal irregular data
- ~100% accuracy



(a) Zoomed out epicenter with color gradient reflecting time-difference from detection.

Table 4.12: Comparison of different models on the epicenter aligned dataset case.

Model	Precision	Recall	Accuracy	F_1	loss
VAKE Association Module	0.4516	0.2857	0.3067	0.3500	-
A-TrajFormer Base	0.9149	0.9348	0.8814	0.9247	0.0476
A-TrajFormer Spatial	**1.0**	0.8824	0.9016	0.9375	0.0132
A-TrajFormer Temporal	**1.0**	0.9592	0.9661	0.9792	0.0050
A-TrajFormer Course	**1.0**	**1.0**	**1.0**	**1.0**	0.0029
A-TrajFormer with All Augmentations	**1.0**	**1.0**	**1.0**	**1.0**	**0.0027**

Thank you!

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