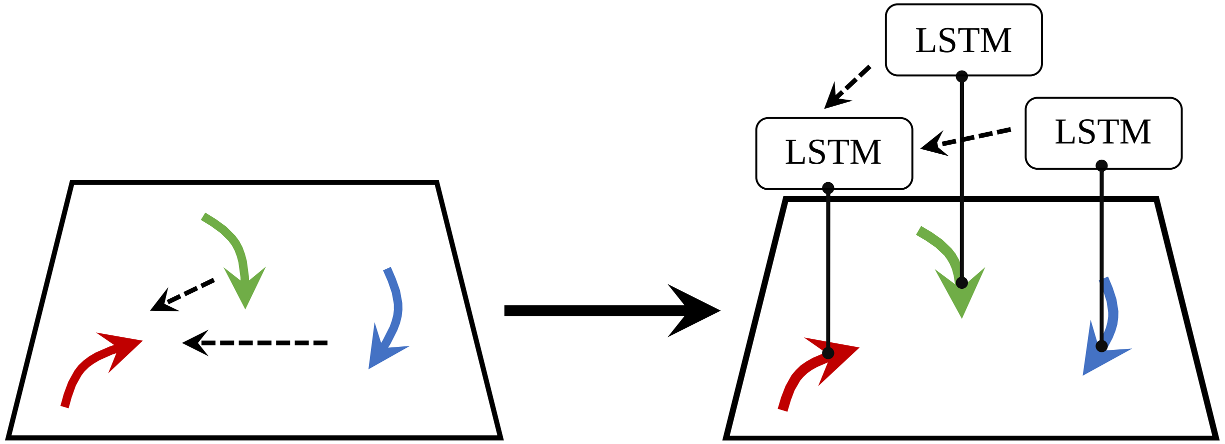
9a.016.UVA : A Data Driven Approach To Jointly Modeling Intent For Diverse Agents

Safe navigation in multi-agent scenarios requires the ability to predict future trajectories of surrounding agents.

Motivation



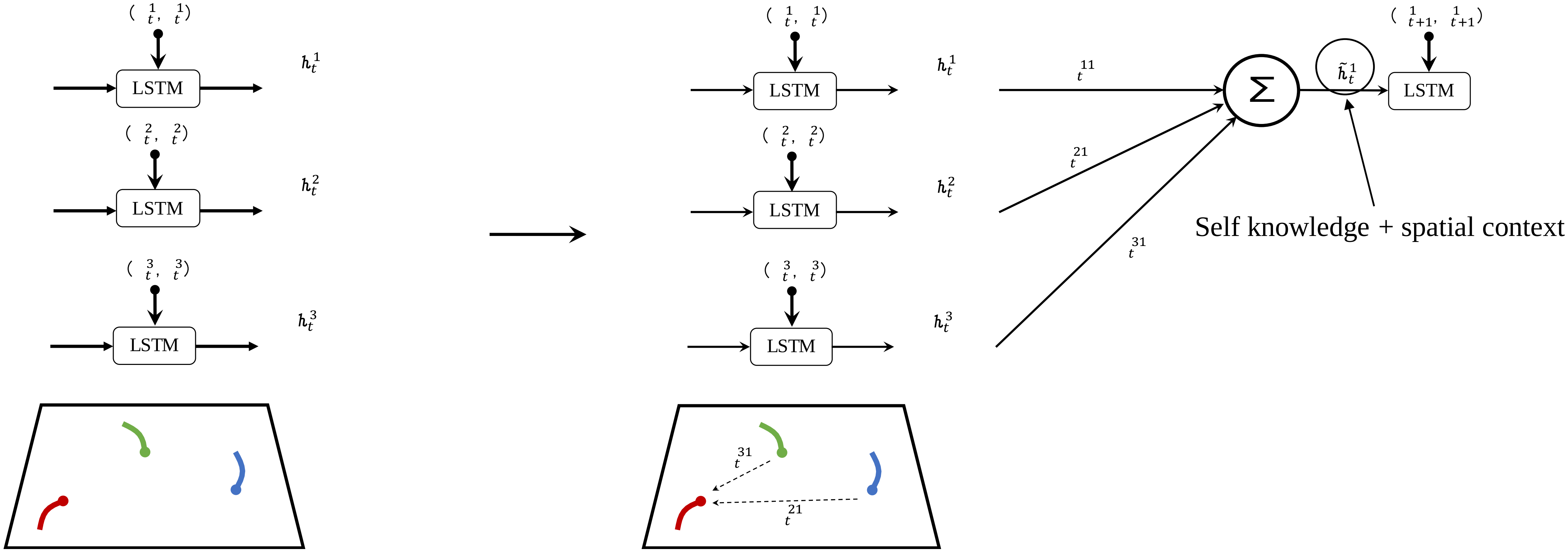
Goal: Predict future intent for all agents navigating in an environment

Intuitively, LSTMs can be used to model an agent's future trajectory given observed trajectory

However, every agent's trajectory is also influenced by its neighbors' current positions and their intents. LSTMs cannot capture such spatial interactions

We propose a **Spatial Attention Mechanism** which enables each LSTM to take into account the spatial influence of each neighbor at every timestep in the observed and predicted trajectory

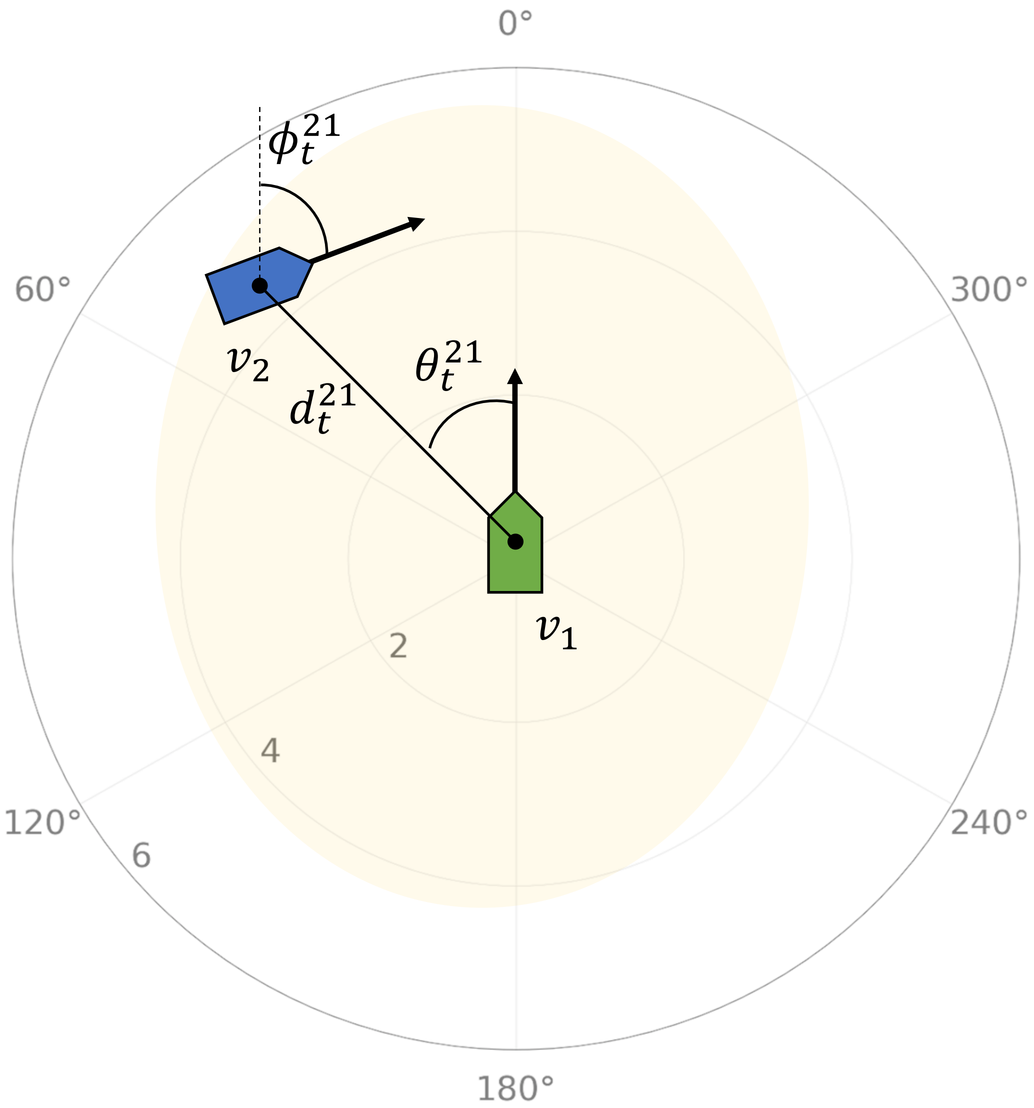
Spatial Attention Mechanism



Our model consists of an LSTM-based encoder and an LSTM-based decoder

At every timestep, the spatial attention mechanism computes weights proportional to spatial influence of each neighbor.

Spatial Attention Mechanism



The influence of v_2 on v_1 at t is modeled as:

$$w_t^{21} = max(0, (S(\theta_t^{21}, \phi_t^{21}) - d_t^{21})$$

SHIP DOMAIN

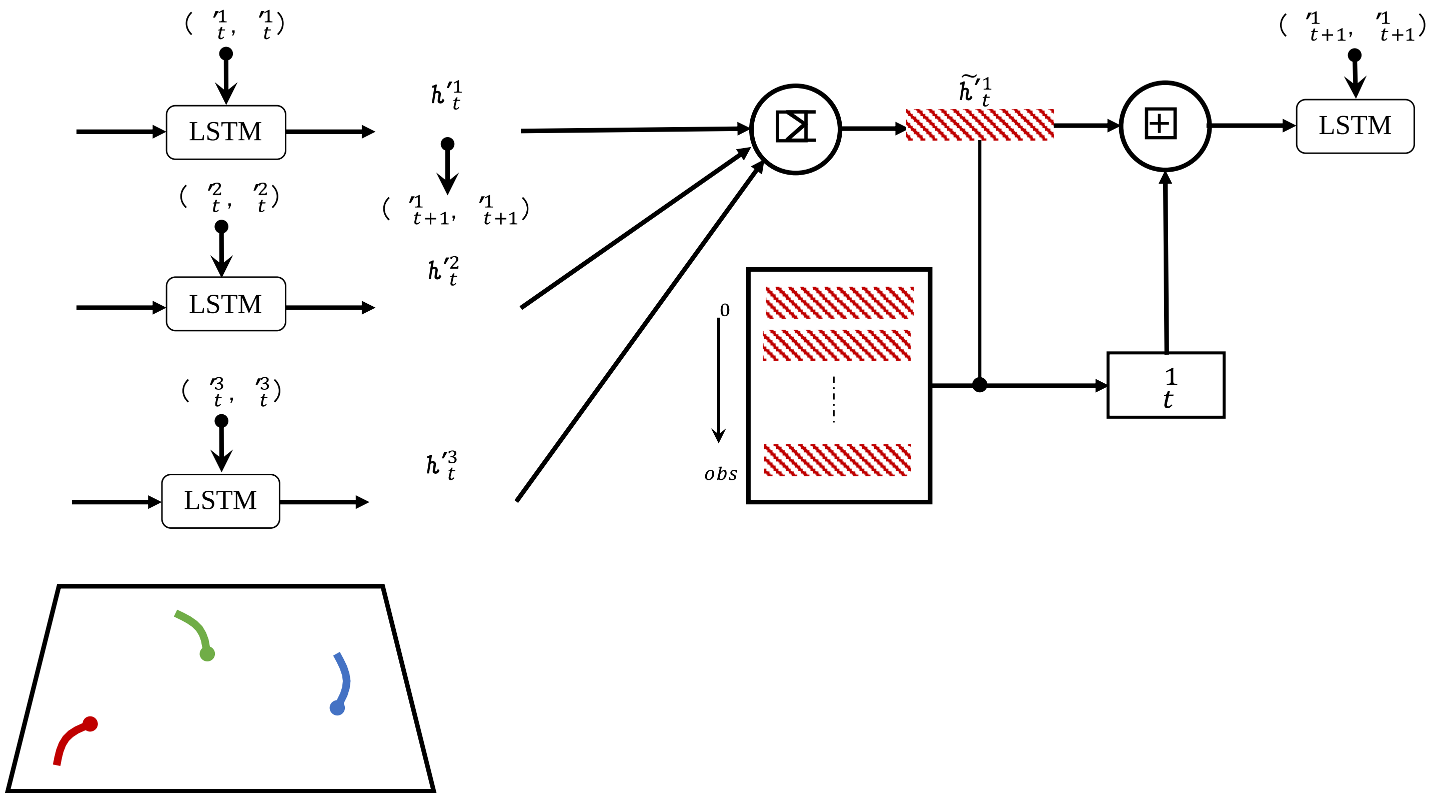
(trainable parameter)

An area around v_1, the intrusion of which by any other vessel v_2 would cause a direct influence on the future trajectory of v_1

if $d_t^{21} > S(\theta_t^{21}, \phi_t^{21})$, then $w_t^{21} = 0$;

else, $w_t^{21} = S(\theta_t^{21}, \phi_t^{21}) - d_t^{21}$

Temporal Attention Mechanism

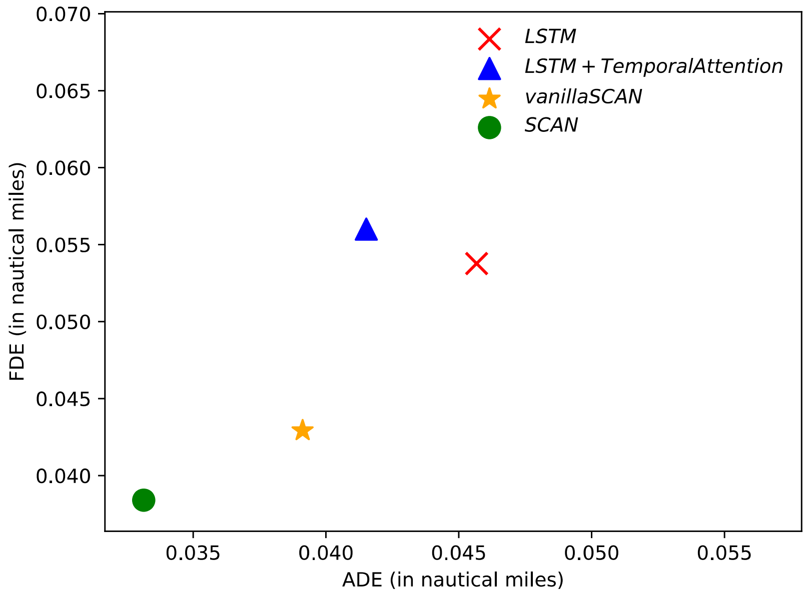


When making a prediction, the decoder assigns a score of similarity to all weighted hidden states in the encoder

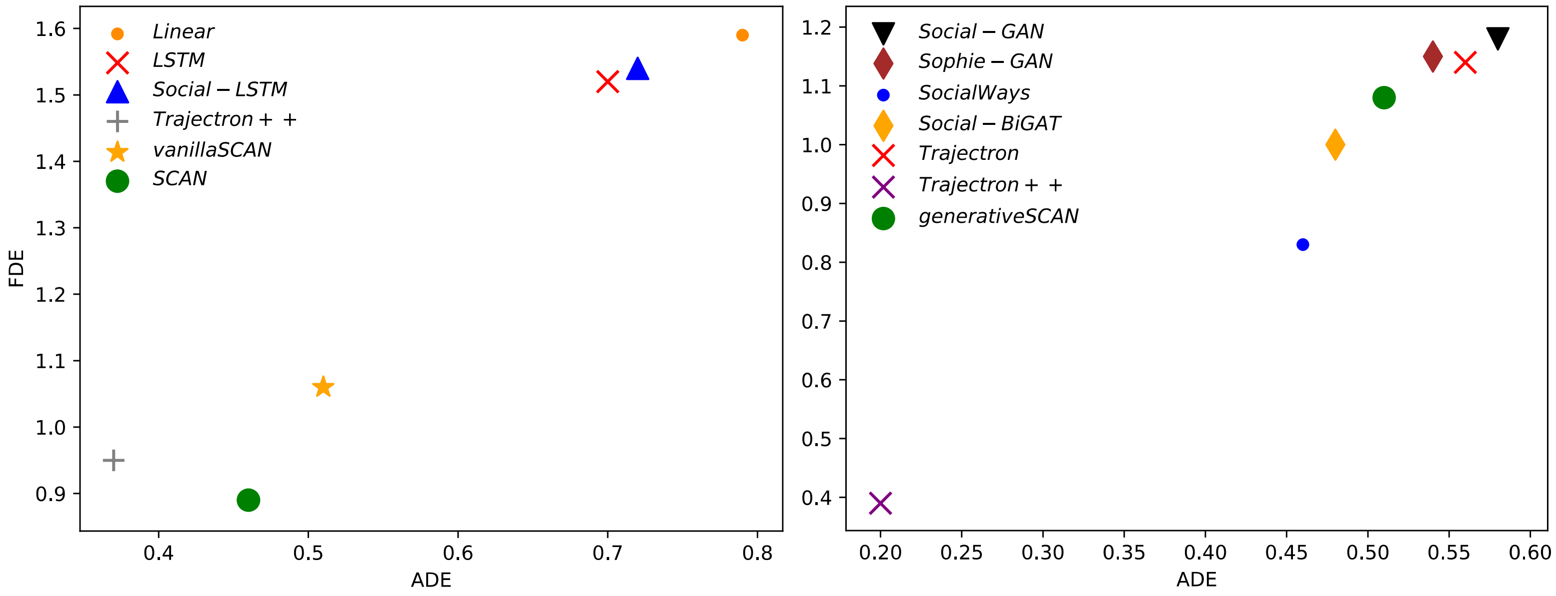
More similar the observed spatial context to the current spatial context, more influential it is towards prediction at the next step

Quantitative Analysis

On AIS Data for Ships



On ETH, UCY Datasets (Pedestrians)

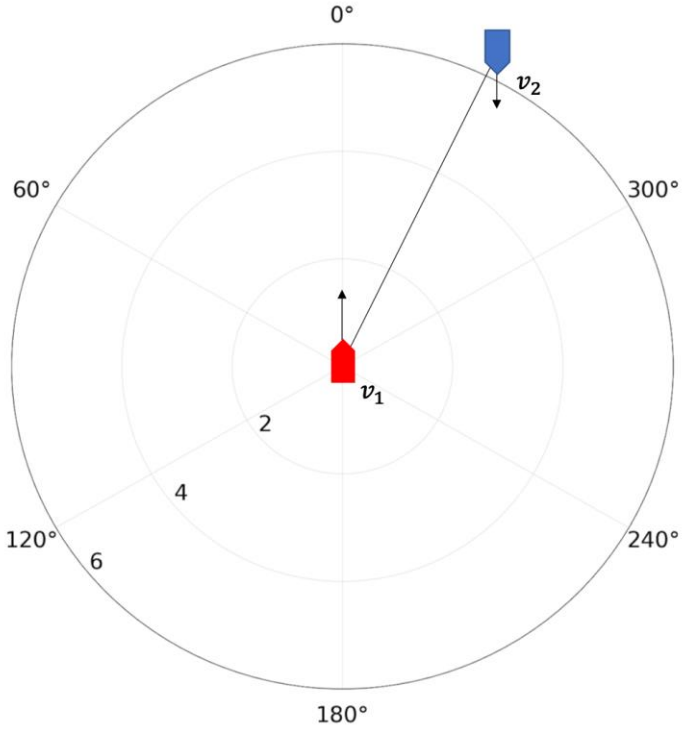


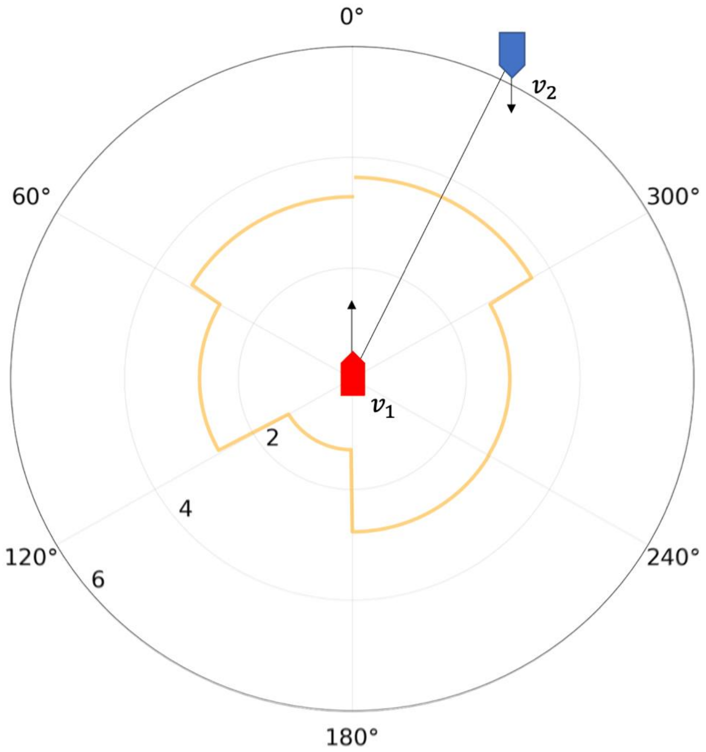
SCAN : **S**patial **C**ontext **A**ttentive **N**etwork

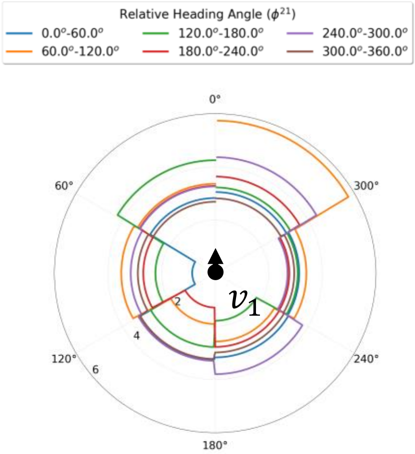
vanillaSCAN: SCAN without the temporal attention mechanism

generativeSCAN: GAN-based *SCAN* which is able to predict multiple socially feasible trajectories per pedestrian in the scene

Learned Domain for Ships on AIS Data







v_2 : neighboring vessel
v_1 : ownship

The yellow line denotes the learned ship domain. As the orientation and distance of v_2 from v_1 changes, the model adjusts the learned ship domain to incorporate spatial influence of v_2 on v_1.

Future Directions

- Extend to modeling interdependencies between diverse agents navigating in a scene e.g. urban road traffic
- Incorporating scene context e.g. building entrances, sidewalks, non-traversable areas, etc.