

# Surface prediction for navigation

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# Problem setup

- Navigator is complex, strongly depends on by-hand-optimization, polymorphic, hard to parallelize...

**Idea:** Learn navigation from simulated data (ML)

**Task:** Predict *next surface* based on *current surface* and *track parameters*

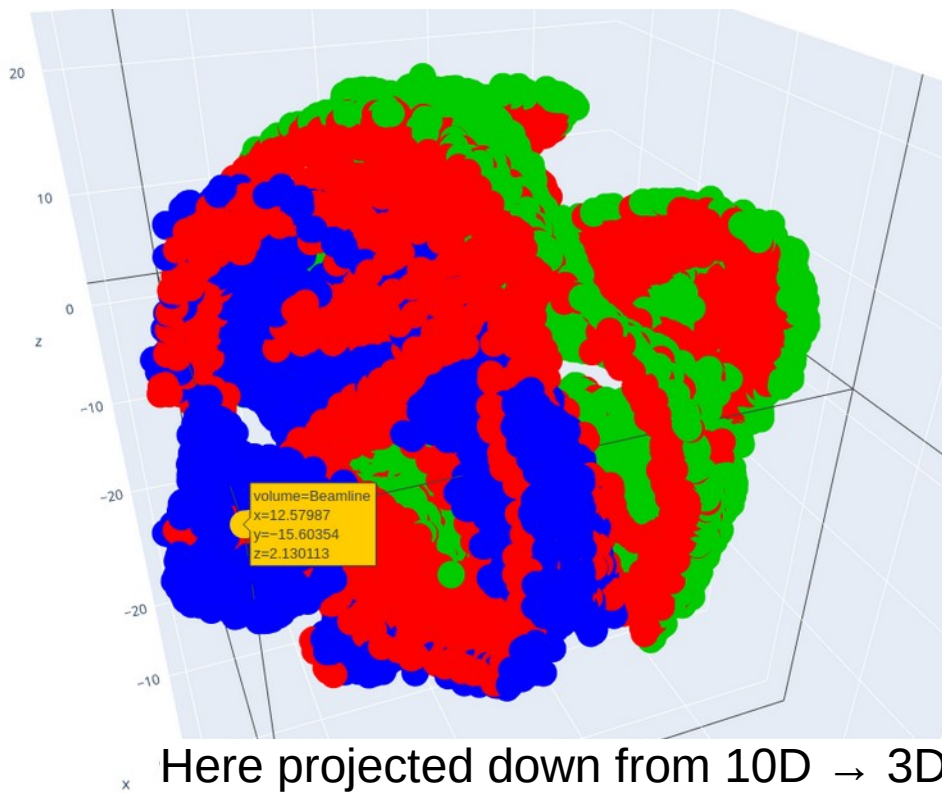
# Surface representation

- Surface is a Categorical variable (Acts :: GeometryId)
  - **One-Hot Encoding** not suited well
  - **Embedding** (also known from e.g., language processing)

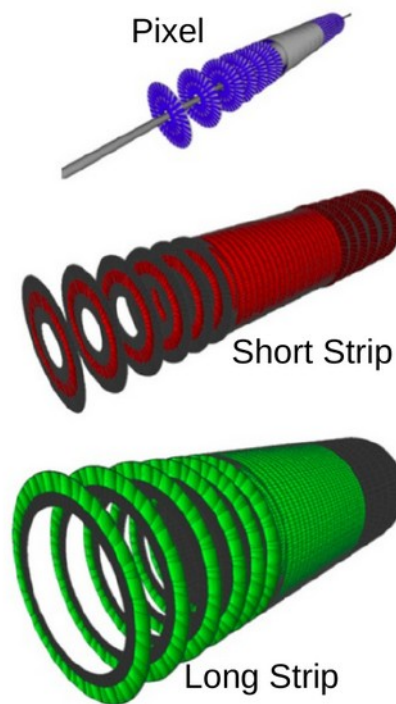
$$\{x \in \mathbb{N} \mid 0 \leq x < N_{surfaces}\} \rightarrow \mathbb{R}^d$$

# Embedding

Learned Embedding

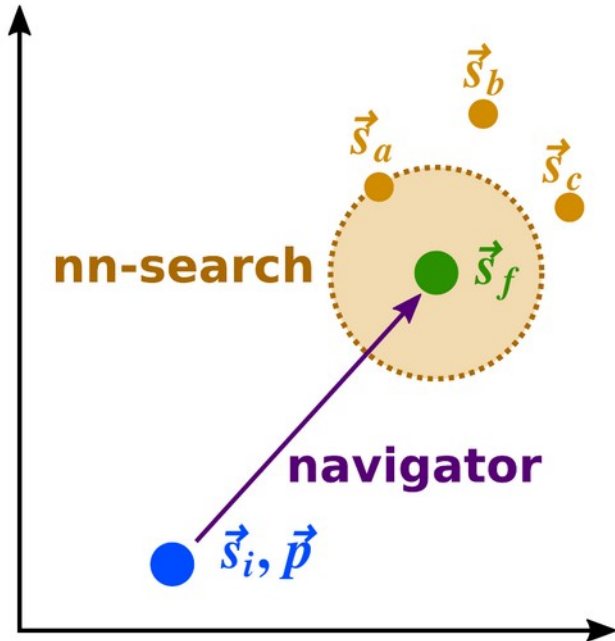


Real Space 3D Coordinates

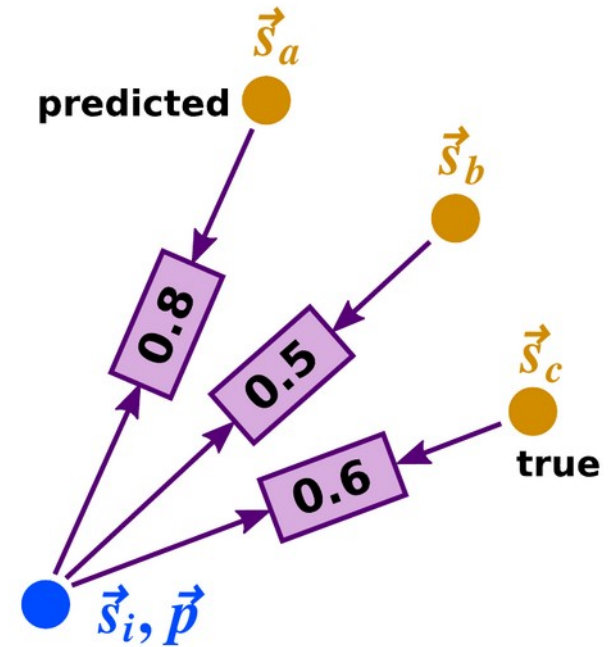


# Approaches

Without candidates:  
(*target prediction*)



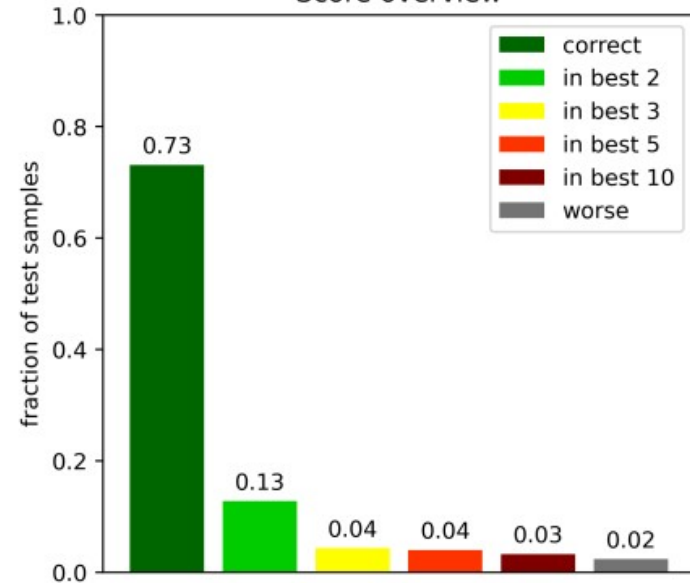
With candidates:  
(*score prediction*)



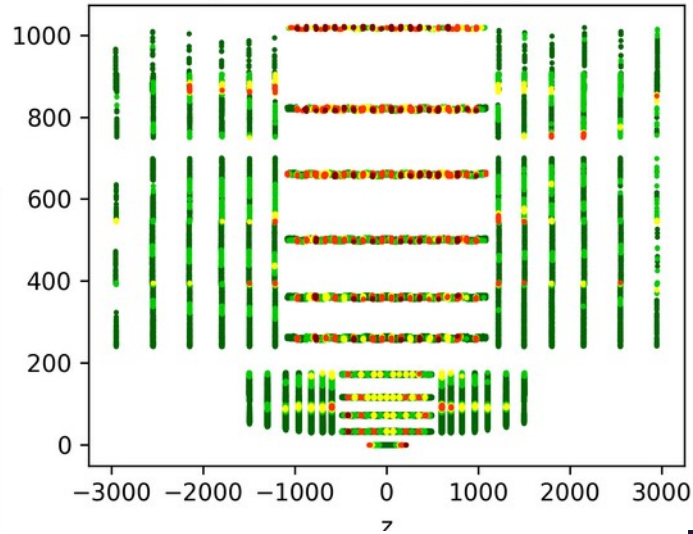
# Results Target-Pred (TrackML)

Uses trained 10D embedding

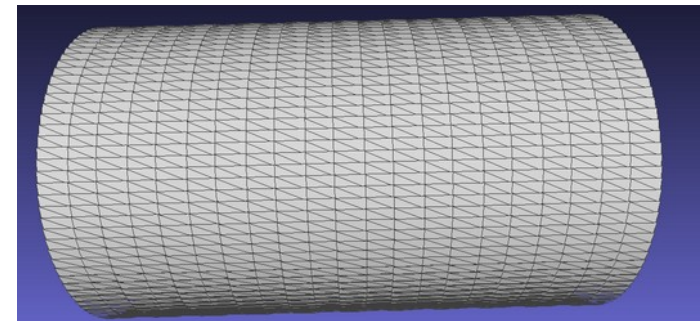
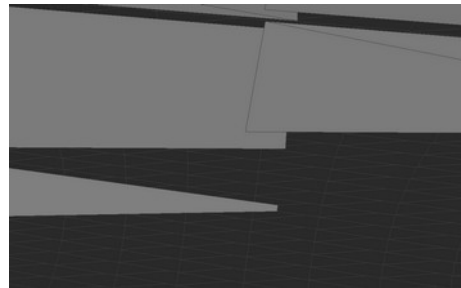
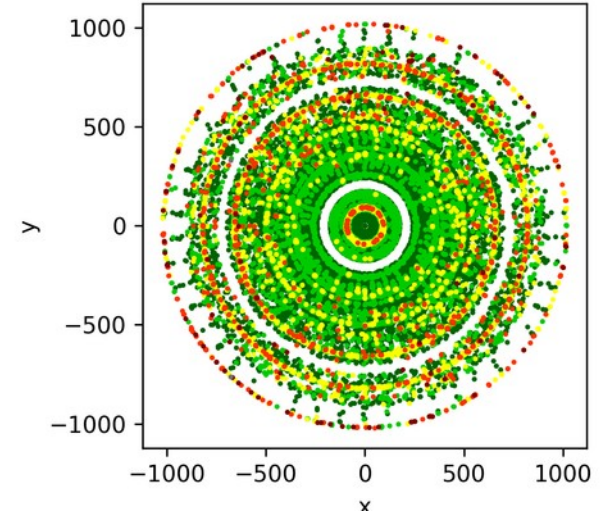
Score overview



target prediction: r-z projection



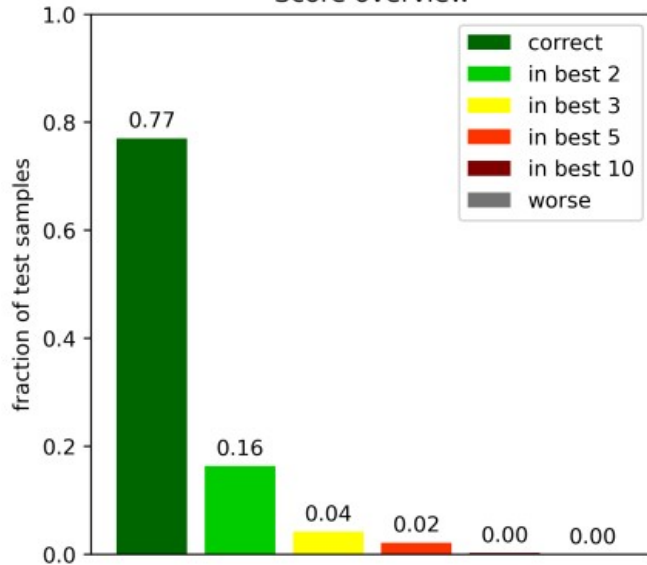
target prediction: x-y projection



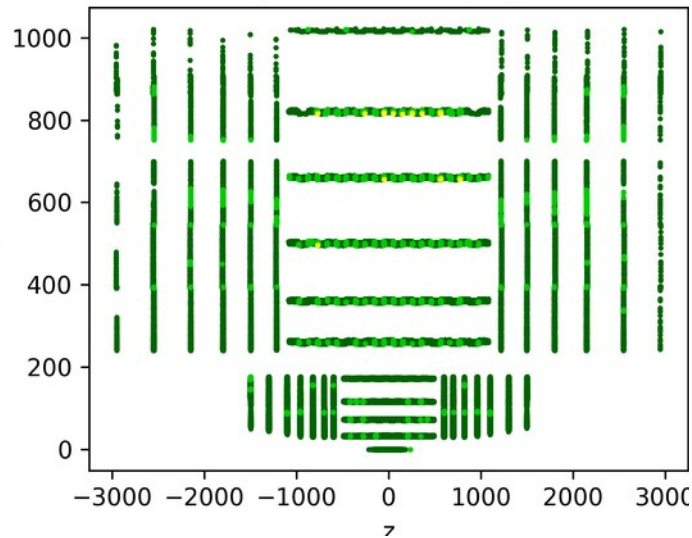
# Results Score-Pred (TrackML)

Uses 3D real-space embedding

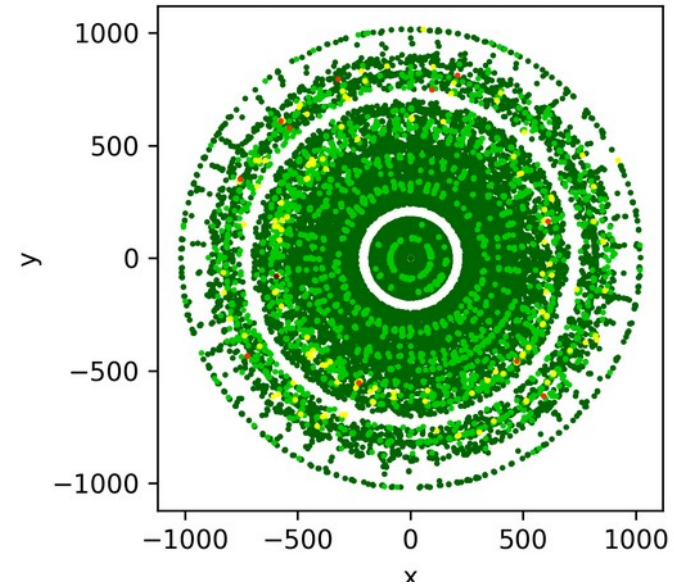
Score overview



score prediction: r-z projection

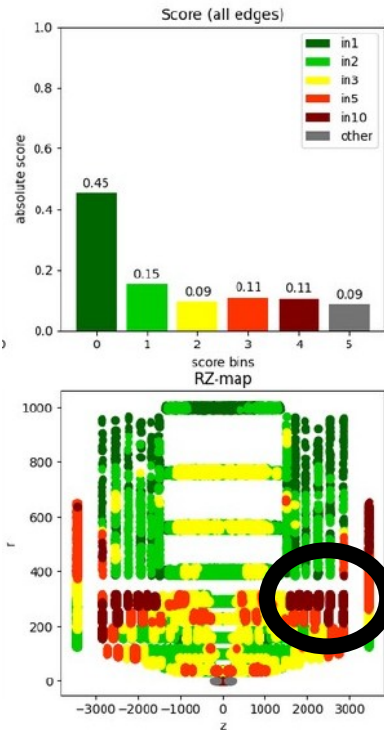


score prediction: x-y projection



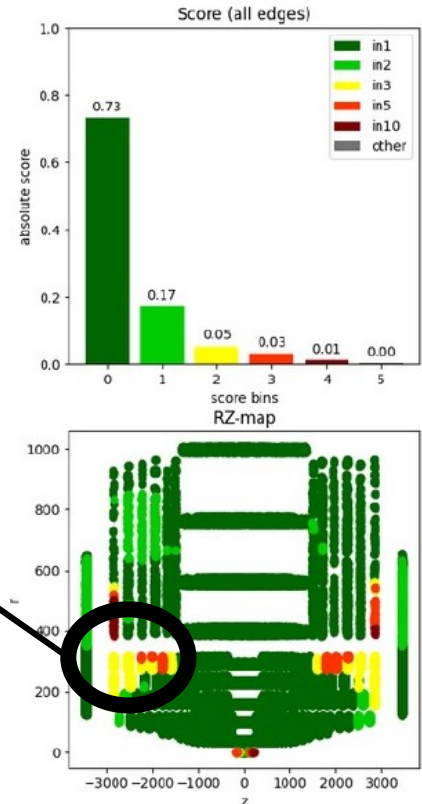
# ITk detector results

Target prediction



- Preliminary results
- Not representative due to training data problem

Score prediction





# Next steps

- Computational performance
- Implementation in Acts (ONNX)
- Some other approaches/network architectures to try