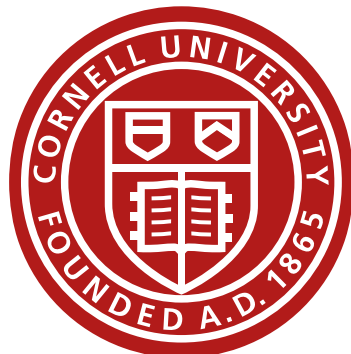


N²: A Unified Python Package and Test Bench for Nearest Neighbor-Based Matrix Completion

Caleb Chin, Aashish Khubchandani, Harshvardhan Maskara, Kyuseong Choi, Jacob Feitelberg, Albert Gong, Manit Paul, Tathagata Sadhukhan, Anish Agarwal, Raaz Dwivedi



Motivation

Nearest neighbor (NN) methods are effective tools for matrix completion applications but:

- There's no unified and extendable framework to consolidate NN methods for rapid experimentation and development.
- There's no standardized real-world benchmarks for matrix completion methods across multiple real-world datasets.

Solution

N² is a **unified Python package** and **testbed** designed to:

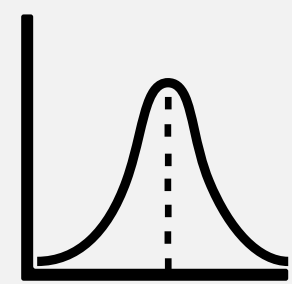
- Consolidate a broad class of NN-based methods through a **modular, extensible interface**.
- Stress-test matrix completion methods on **diverse real-world datasets** from healthcare and recommendation systems to causal inference and LLM evaluation.

N² Framework

Data Type

Entry type:

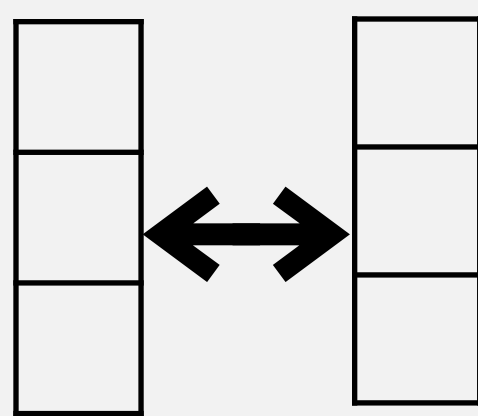
1234



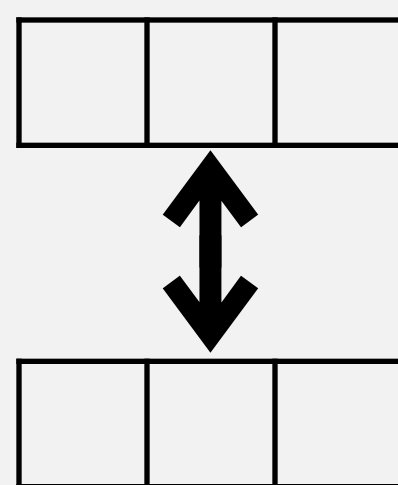
Define:

- DISTANCE
- AVERAGE

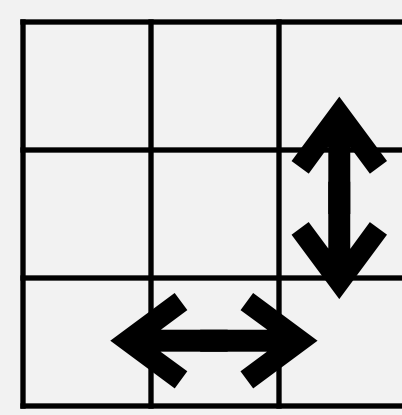
Estimation Method



ColNN



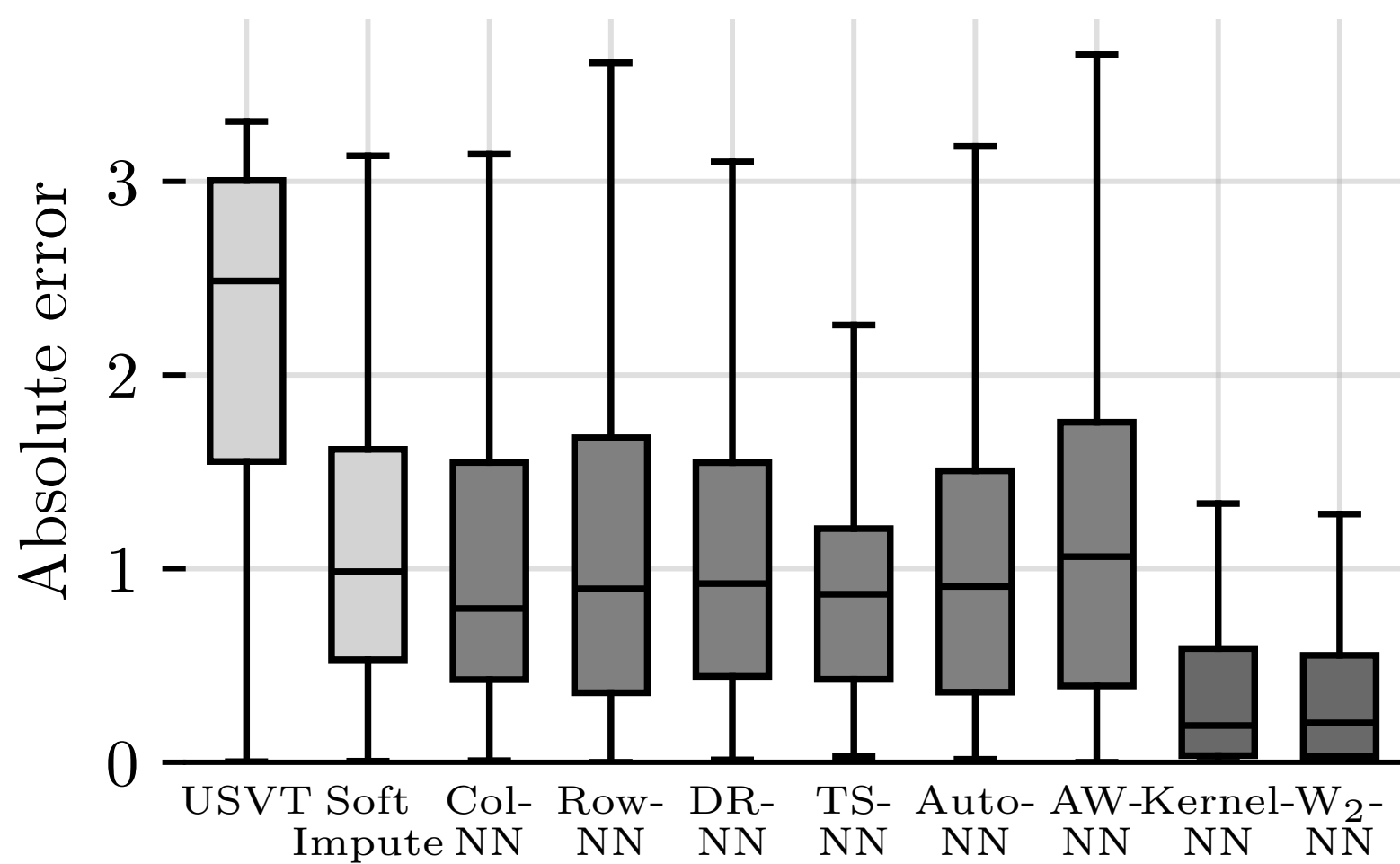
RowNN



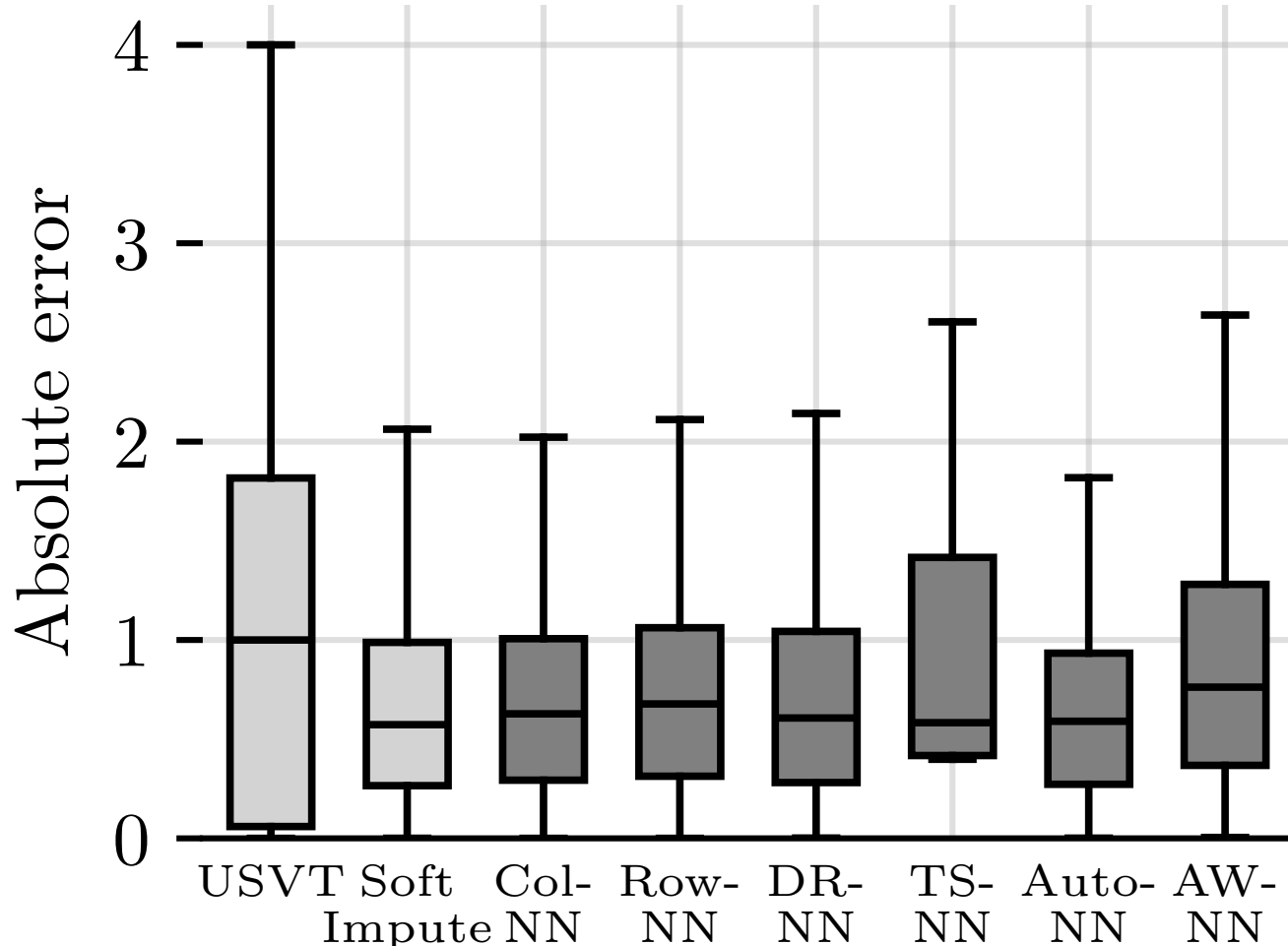
DRNN, TSNN, ...

N²-Bench

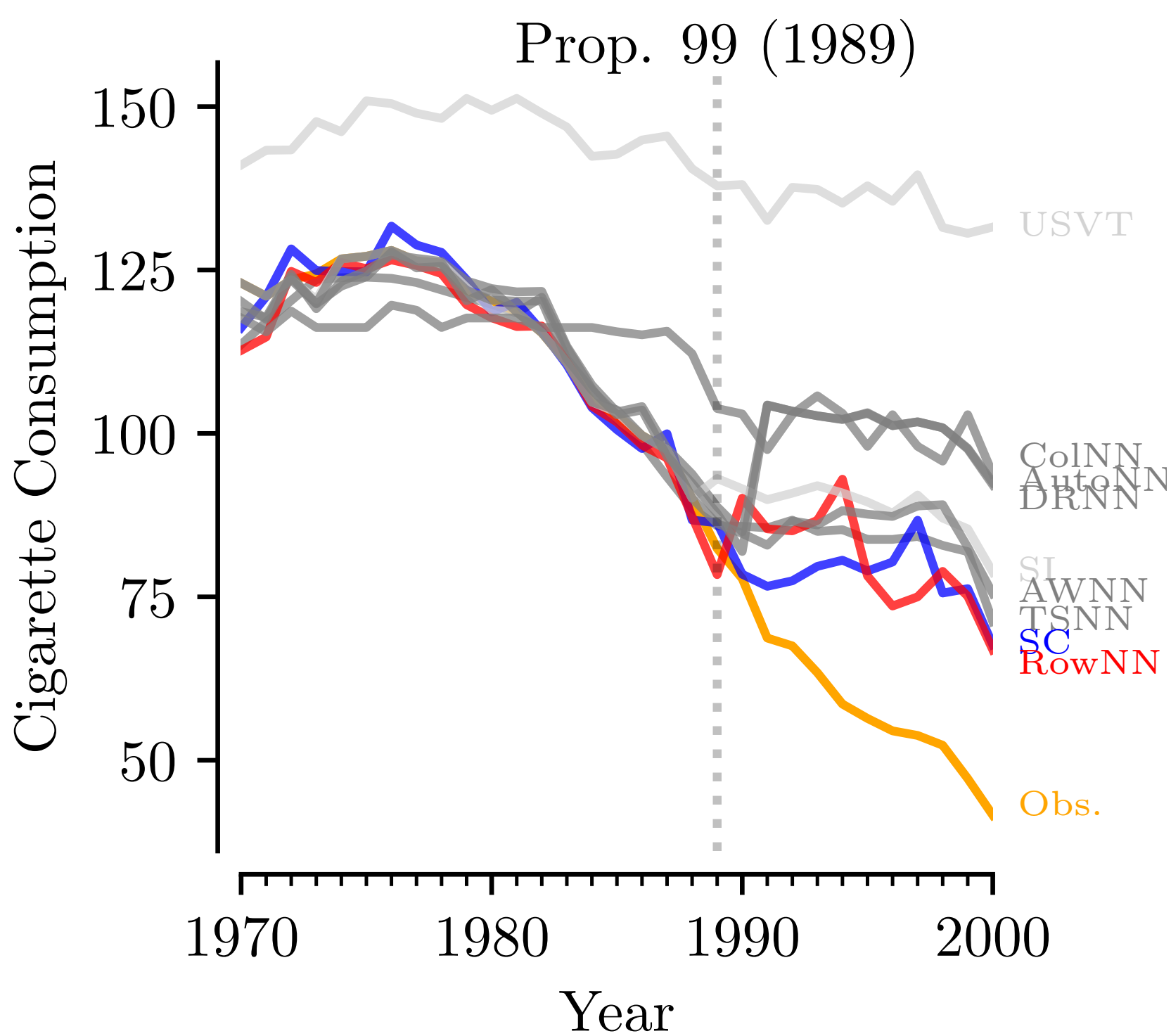
Personalized Healthcare: Heartsteps Study



Recommendation Systems: MovieLens



Counterfactual Inference: California Prop. 99



Takeaways

- Across-the-board reductions in error.
- Our findings lead us to introduce AutoNN, which automatically adjusts to the underlying noise level and debiases automatically.
- The modularity of the package and testbed allows for easy prototyping and benchmarking of new NN approaches.

Paper



GitHub



N²: A Unified Python Package and Test Bench for Nearest Neighbor-Based Matrix Completion



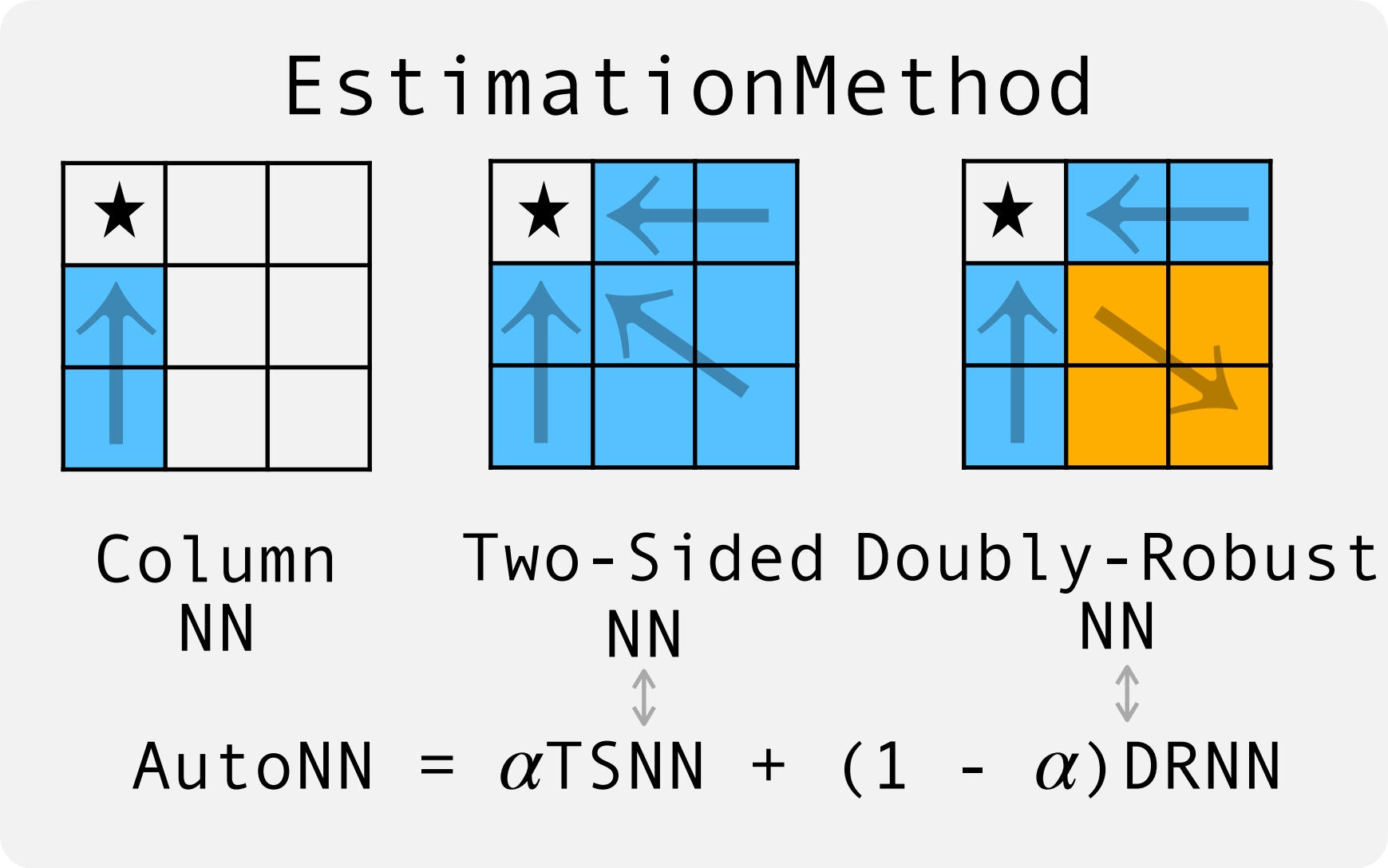
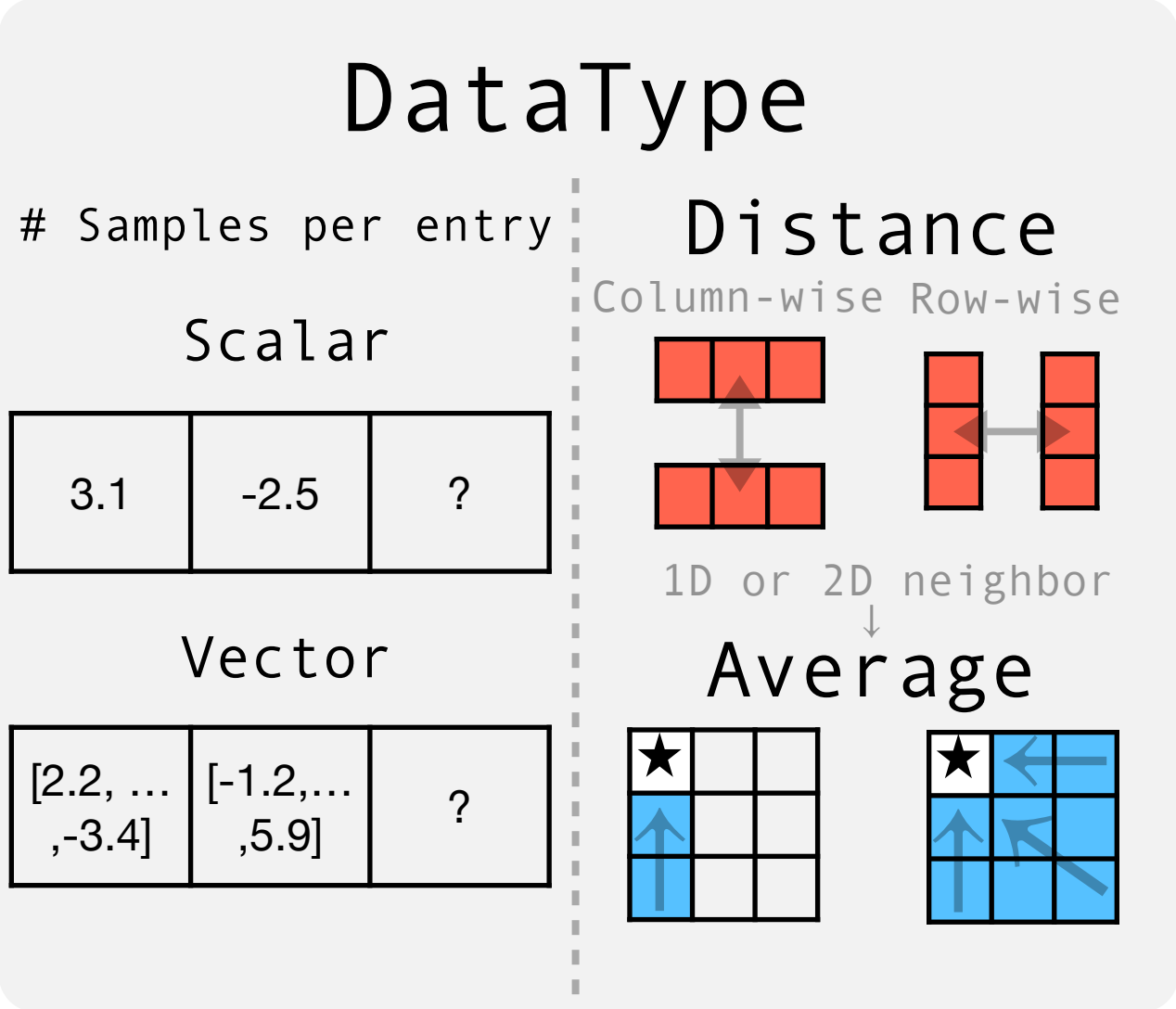
Motivation

- Nearest neighbor (NN) methods are effective tools for matrix completion but:
- A **unified framework** is needed to support rapid experimentation and development.
 - **Standardized benchmarks** are needed for evaluating matrix completion methods across real-world scenarios.

Solution

- N² is a **unified Python package** and **testbed** to:
- Consolidate a broad class of NN-based methods through a **modular, extensible interface**.
 - Stress-test matrix completion methods on **diverse real-world datasets**, spanning healthcare, recommendation systems, causal inference, and LLM evaluation.

N² Framework



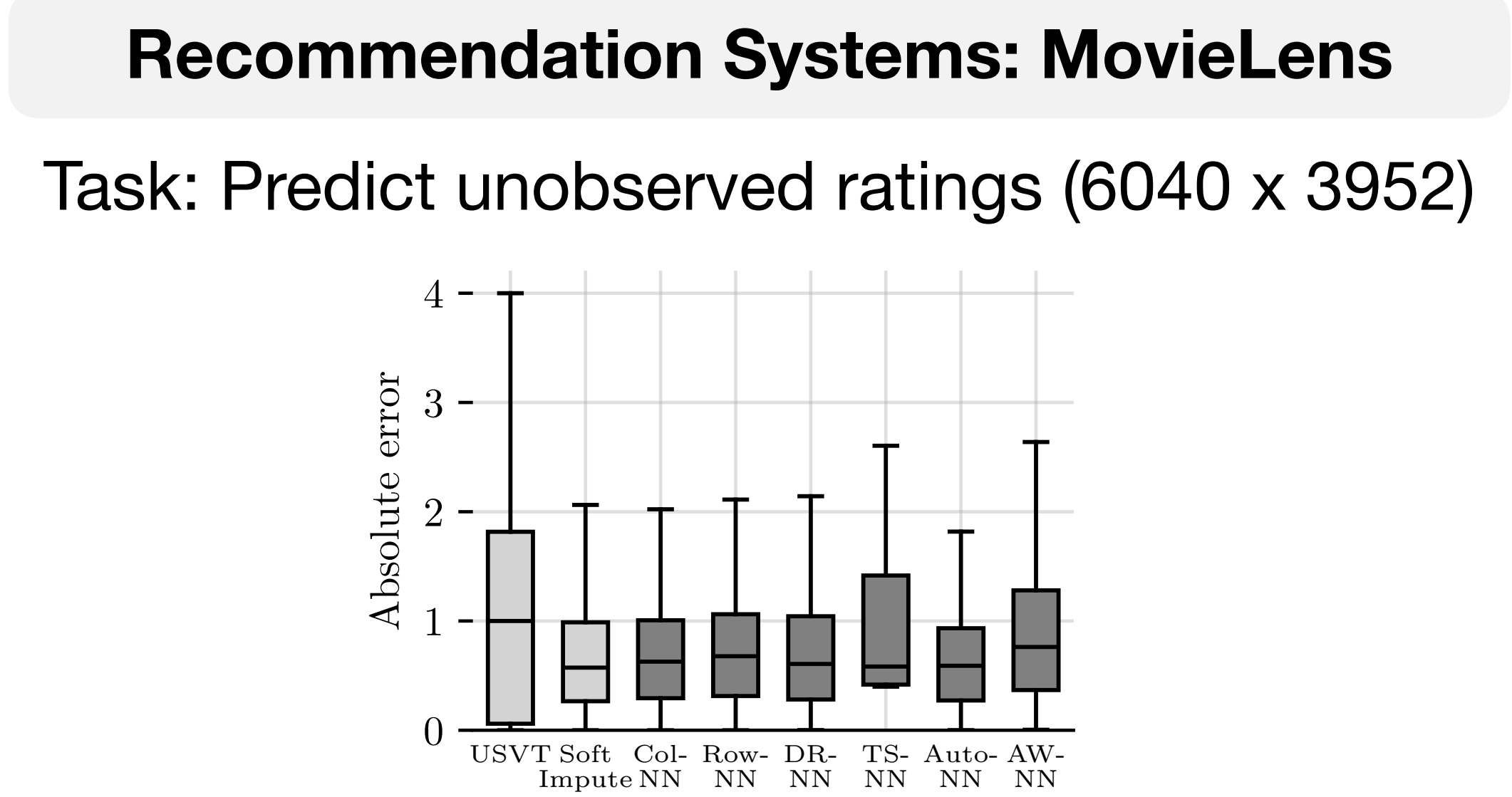
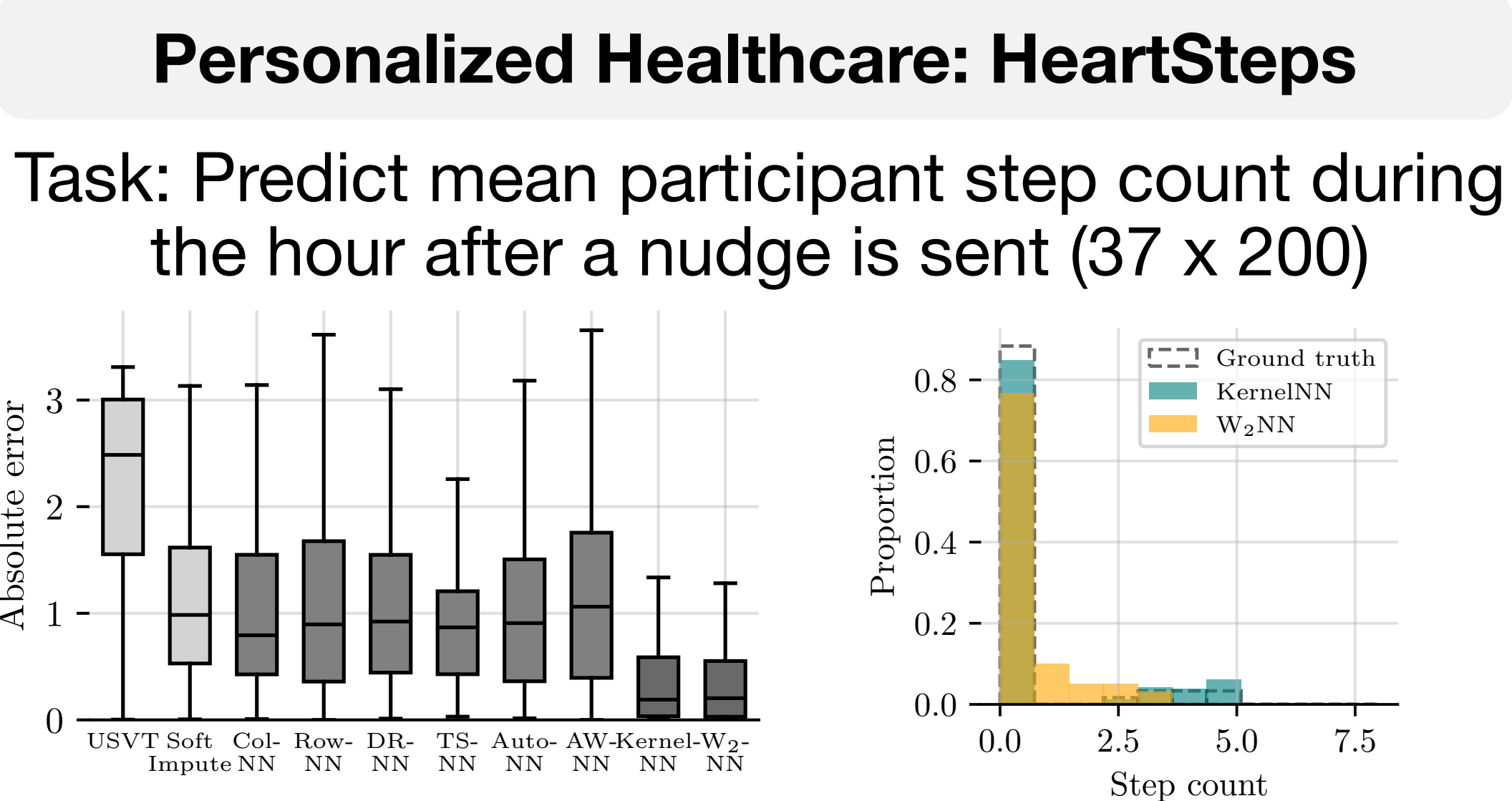
```
from nsquared. estimation_methods import RowRowEstimator
from nsquared. data_types import Scalar
from nsquared. fitting_methods import LeaveBlockOutValidation

# Instantiate the NN modules
estimator = RowRowEstimator()
data_type = Scalar()
imputer = NearestNeighborImputer(estimator, data_type)

# Fit the NN threshold using cross validation
fitter = LeaveBlockOutValidation(
    block,
    distance_threshold_range=(0,1),
    n_trials=100,
    data_type=data_type
)
fitter.fit(data, mask, imputer)

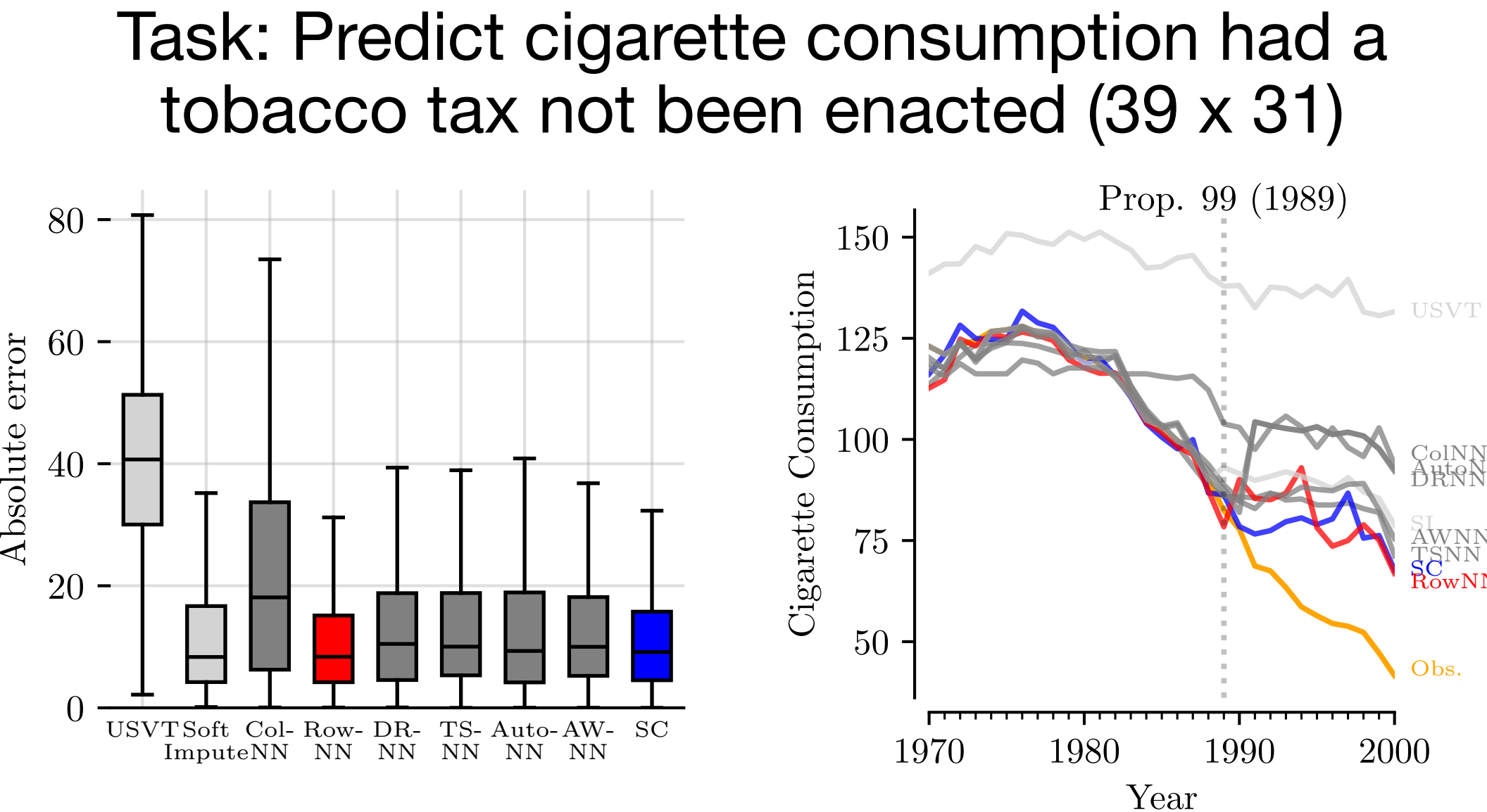
# Impute the (row, col) value given data and mask matrix
imputed_value = imputer.impute(row, col, data, mask)
```

N²-Bench



1. NN-based techniques perform on-par or better than classical methods in real-world scenarios.
2. N² and N²-Bench enable easy prototyping and benchmarking of new NN methods.
3. We introduce AutoNN, which adjusts to the underlying noise level and debiases automatically.

Counterfactual Inference: California Prop. 99



Efficient LLM Evaluation: PromptEval

