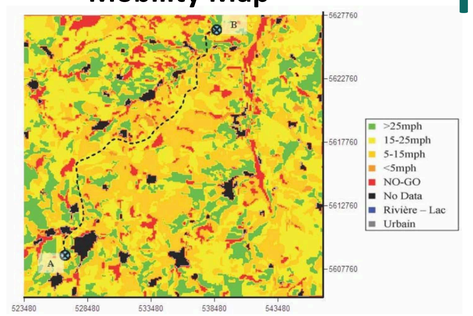
Motivation

- Constructing mobility maps requires thousands of physics-based simulations, each of which can take weeks using high-performance computing[1].
- Trained machine learning (ML) classifiers can quickly generate mobility maps[2].
- According to PAC learning theory, data that can be separated by a classifier is expected to require up to O(1/ε) **randomly selected points**[3] (simulations) to train the classifier with error less than ε.



Results

- We constructed a test function using da simulations.
- QBag can significantly reduce the numb train multilayer perceptron (MLP) and S
- With 100 points, the MLP that used QB to the MLP that was trained with 300 ra

Objective

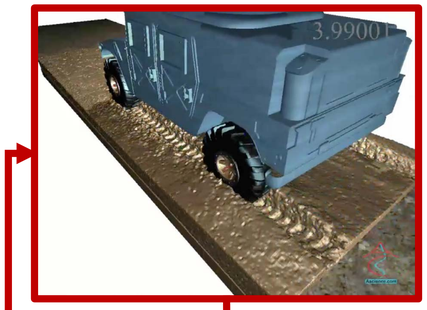
- Develop a sampling technique that will train ML classifiers using far fewer simulations.

Approach

Active Learning Paradigm for Terramechanics

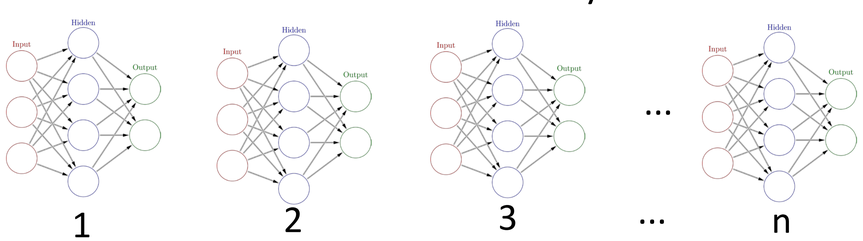
Randomly Choose a Few Points From Unlabeled Pool → Run Simulations to Obtain Labels (Speed-Made-Good) → Add Labeled Point(s) to Labeled Pool → Train Ensemble Using Labeled Pool → Use QBag[4] to Select Informative Point(s) from Unlabeled Pool → Generate Data Points for Unlabeled Pool → Randomly Choose a Few Points From Unlabeled Pool

Physics-based Simulation



Ensemble of Classifiers

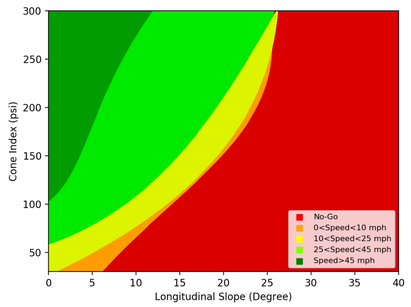
Each classifier is trained on a randomly chosen subset of the labeled data.



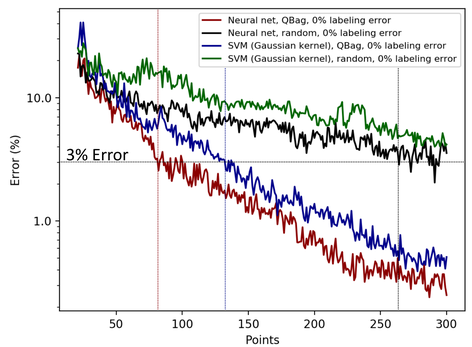
The ensemble consists of n classifiers.

Each classifier predicts the label of each point in the unlabeled pool. If the majority of the classifiers cannot agree on the label of a point, then the point is queried.

Test Function

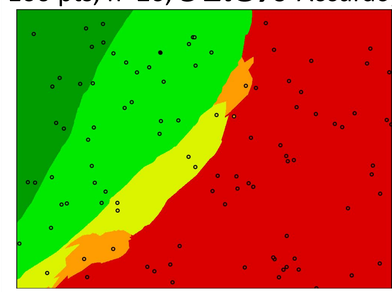


Classifier Errors

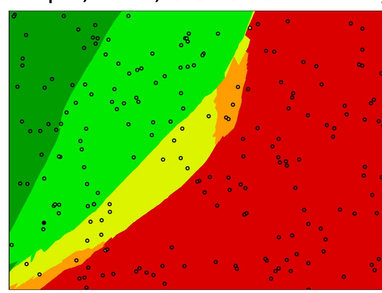


Random Sampling

100 pts, n=20, **91.8%** Accuracy



200 pts, n=20, **95.3%** Accuracy



Future Work

- Increase the size of the feature space to include more variables as the soil density, cohesion, and friction.
- Investigate tools for reducing redundancy when sampling in bat
- Use simulations to label data points that are selected by the act

References

1. McCullough, Michael, et al. "The Next Generation NATO Reference mobility model development." *Journal of Terramechanics*
2. Jayakumar, Paramsothy and Dave Mechergui. "Efficient Generation of Accurate Mobility Maps Using Machine Learning Algo
3. Freund, Yoav, et al. "Selective Sampling Using the Query by Committee Algorithm." *Machine Learning* (1997).
4. Mamitsuka, Naoki Abe Hiroshi. "Query learning strategies using boosting and bagging." *Machine learning: proceedings of th* Morgan Kaufmann Pub, 1998.