CAMIL: Clustering and Assembly with Multiple Instance Learning for Phenotype Prediction

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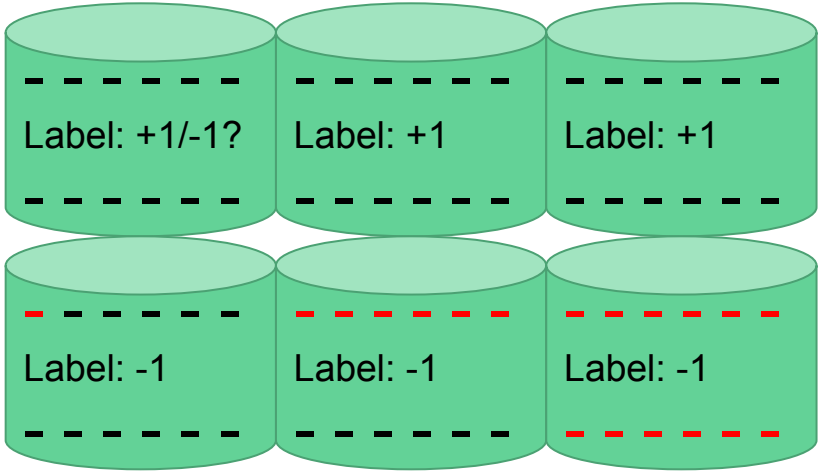
Background: Multiple Instance Learning

- Labeled bags containing unlabeled instances
  - In this context: labeled patients and unlabeled reads

- Instance, Bag, and Embedded Spaces (Amores 2013)*



* J. Amores, “Multiple instance classification: Review, taxonomy and comparative study,” Artificial Intelligence, vol. 201, no. 1, pp. 81–105, 2013.

Goal: Phenotype Prediction with Metagenomic Data

- Predict disease state (“phenotype”) of patient based on metagenome data

- Qin et al. dataset* (2012)

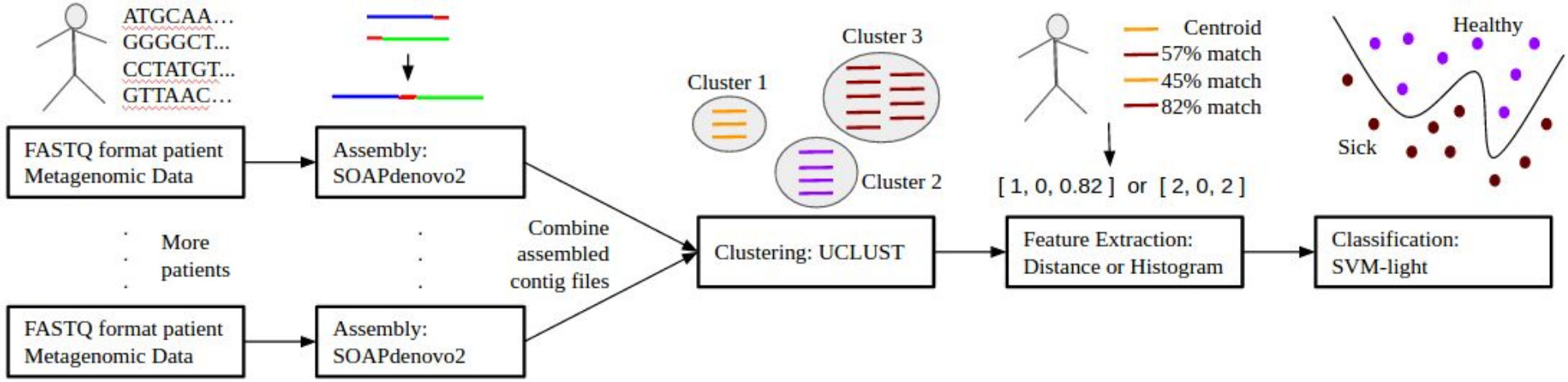
  Type 2 Diabetes

  367 Chinese patients

  Stool samples

* J. Qin et al., “A metagenome-wide association study of gut microbiota in type 2 diabetes,” Nature, vol. 490, no. 7418, pp. 55–60, 2012.

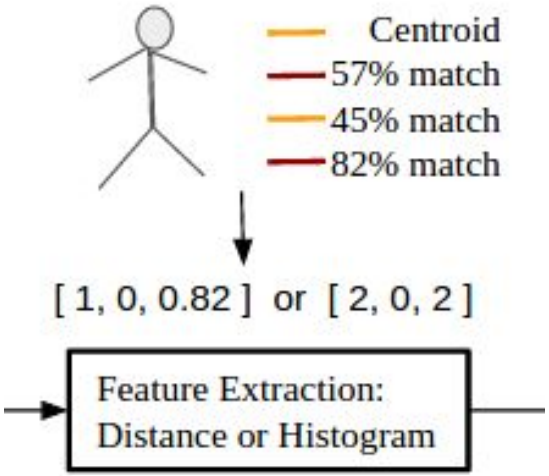
Pipeline



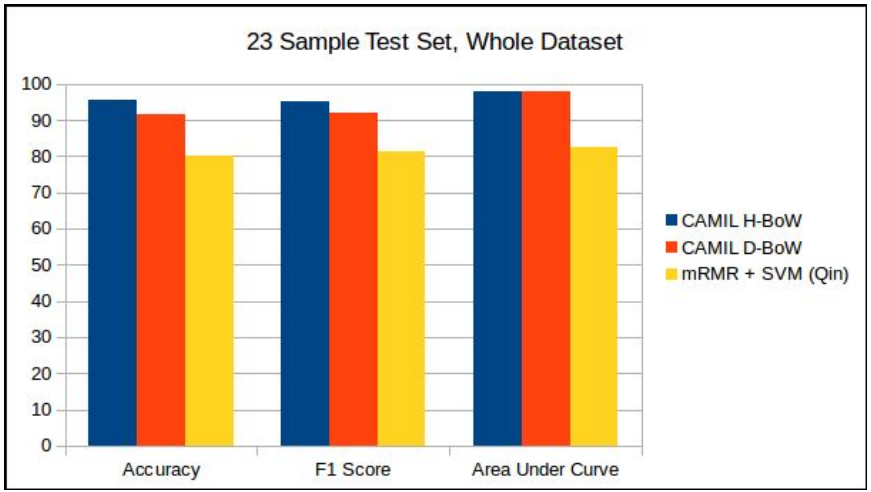
FASTQ Data → Assembly → Clustering → Feature Extraction → SVM Classification

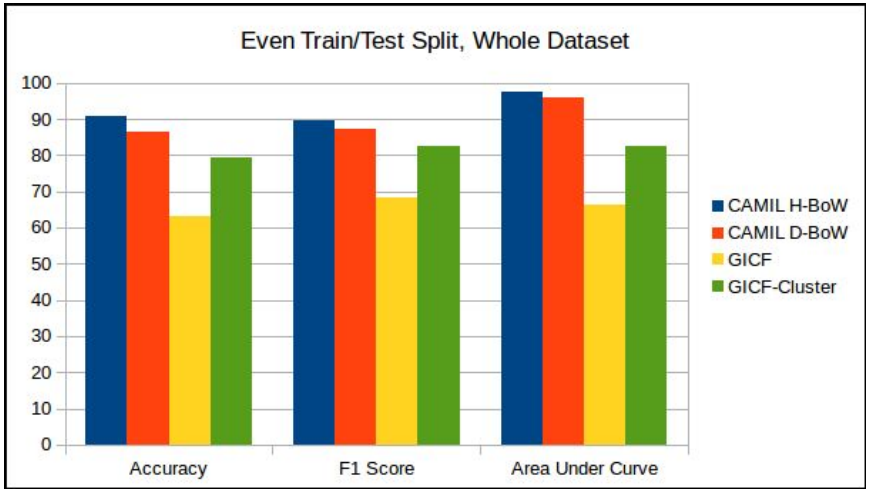
CAMIL Feature Extraction

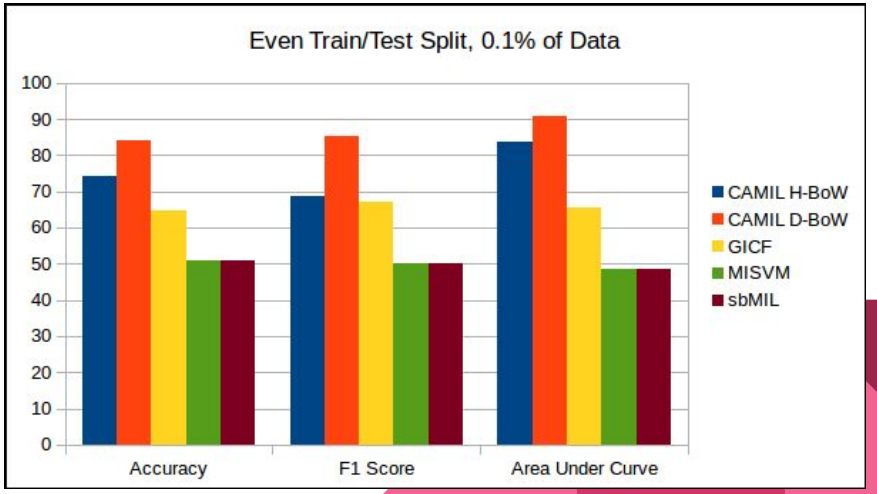
- MIL: Vocabulary-based methods
  - “Bag of Words”
- Histogram Bag of Words (H-BoW)
- Distance Bag of Words (D-BoW)



Results


23 Sample Test Set, Whole Dataset
100
90
80
70
60
50
40
30
20
10
0
Accuracy
F1 Score
Area Under Curve
CAMIL H-BoW
CAMIL D-BoW
mRMR + SVM (Qin)


Even Train/Test Split, Whole Dataset
100
90
80
70
60
50
40
30
20
10
0
Accuracy
F1 Score
Area Under Curve
CAMIL H-BoW
CAMIL D-BoW
GICF
GICF-Cluster


Even Train/Test Split, 0.1% of Data
100
90
80
70
60
50
40
30
20
10
0
Accuracy
F1 Score
Area Under Curve
CAMIL H-BoW
CAMIL D-BoW
GICF
MISVM
sbMIL

Conclusion and Future Work

- MIL can be an effective approach towards phenotype prediction
- CAMIL is a general example of this kind of method
- Future: different clustering & assembly algorithms, different MIL-based feature extraction methods, instance labels