

Multi-Class Classification

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Multi-Class Classifiers

- Naturally Multi-Class Classifiers
 - What are these?
- Two-Class Classifiers
 - What are these?
- Can you solve a multi-class classification problem using a Binary Classifier ?
 - Let's assume the Binary Classifier is an SVM.

Multi-Class Classifiers

1 v/s 1

1 v/s ALL

Multi-Class Classifiers

1 v/s 1

1 v/s ALL

- What about dataset with unbalanced classes?

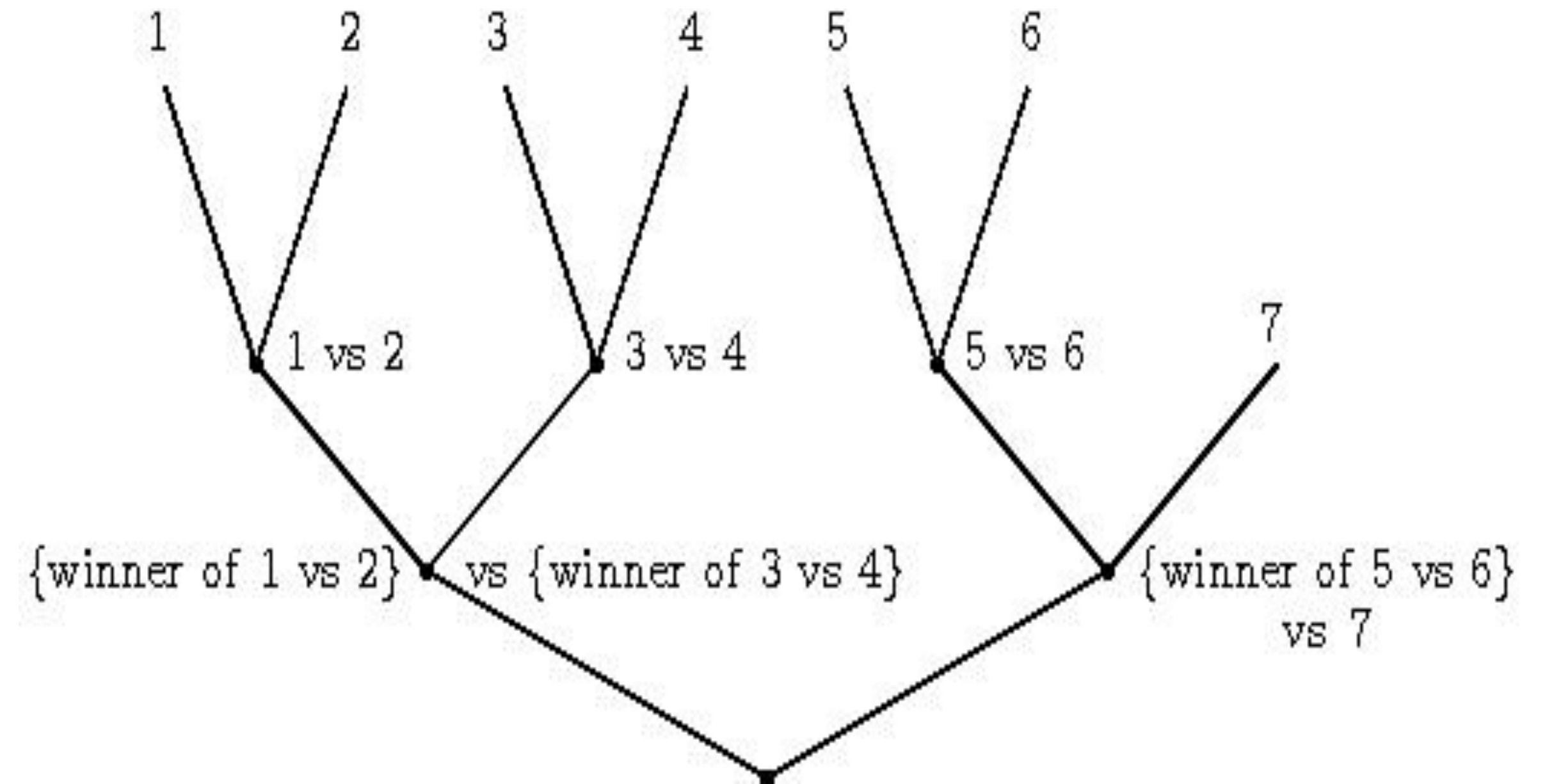
Multi-Class Classifiers

1 vs 1

- Disadvantages?
- How many classifiers do you need in 1 vs 1?
- How about a “Tournament”?

Tournament

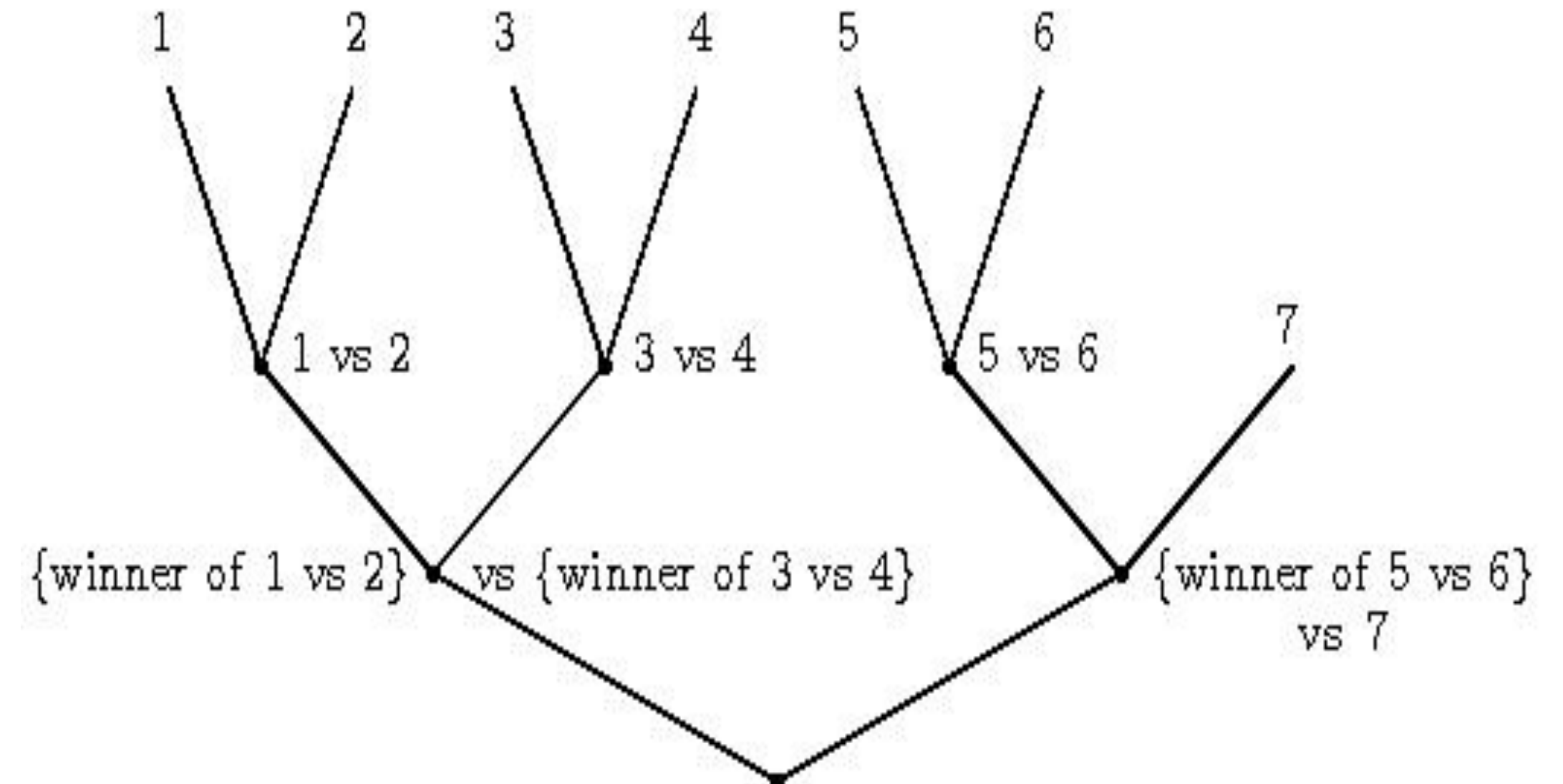
- The problem is essentially finding a better way to reduce multiclass classification to binary classification.
- Single elimination tournament.
 - The “players” are the different classes.
- For the single elimination tournament, we can prove that:



$$reg_{multiclass}(D, Filter_tree_test(c)) \leq reg_{binary}(Filter_tree_train(D), c)$$

Tournament

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- $Filter_tree_train(D)$ is the induced binary classification problem
- $Filter_tree_test(c)$ is the induced multi-class classifier.
- $reg_{multiclass}$ is the multi-class regret (= difference between error rate and minimum possible error rate)
- reg_{binary} is the binary regret

Tournament

- The key insight which makes the result possible is conditionally defining the prediction problems at interior nodes.
- In essence, learned classifiers from the first level of the tree are used to filter the distribution over examples reaching the second level of the tree.
- This process repeats, until the root node is reached.
- These are Conditionally Trained classifiers.

Multi-Class Classifiers

- What if there is a severe class imbalance?
 - What would you do in this case?

Multi-Class Classifiers

- What if there is a severe class imbalance?
 - What would you do in this case?
- Classification in a Hierarchical manner.

Multi-Class Classification

Hierarchical Classification

- Essentially, split the classes into two groups.
- Then within the groups,
 - Assign a specific class or split further into smaller groups.
- So what is the challenge here?

Multi-Class Classification

Hierarchical Classification

- How will you approach Clustering?

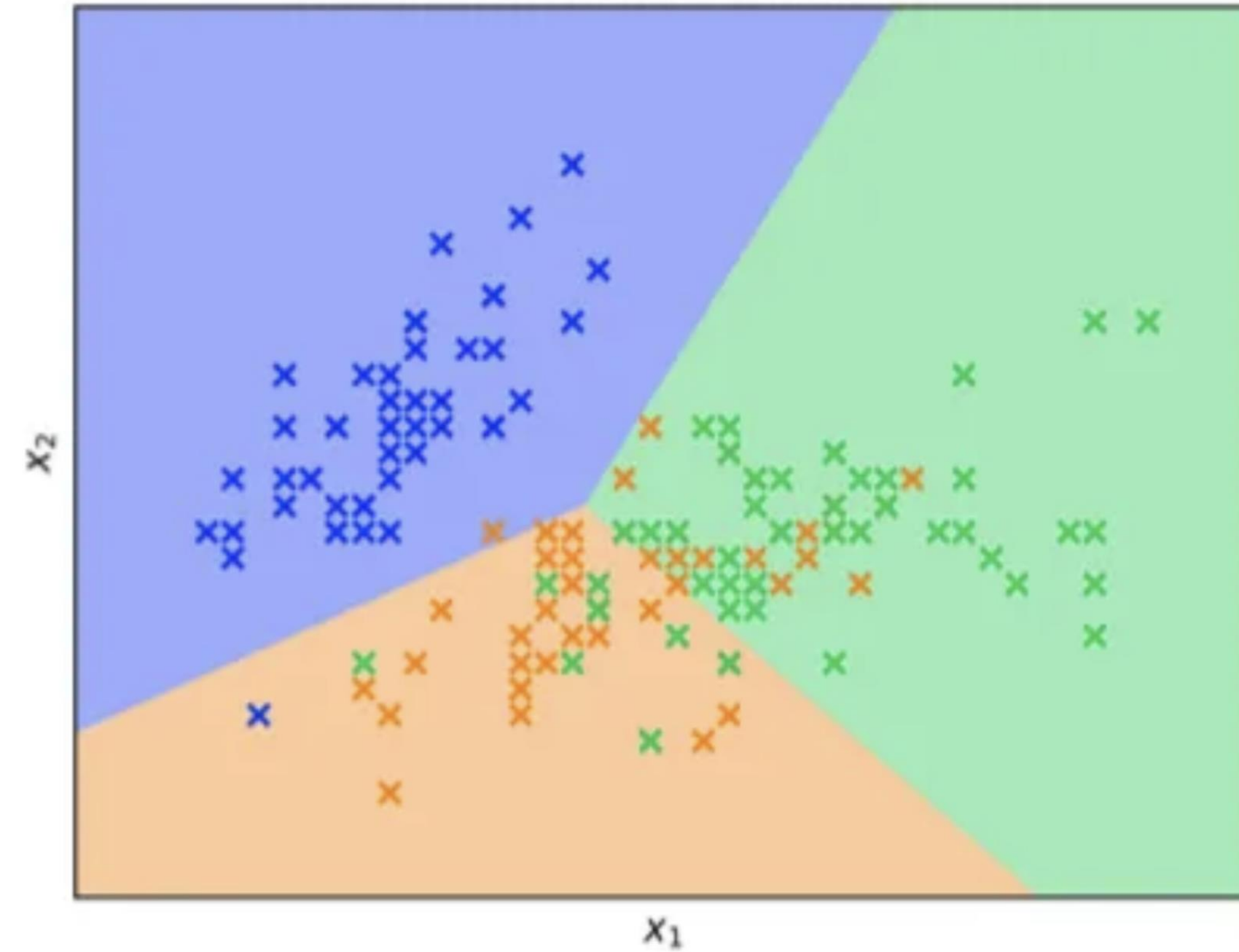
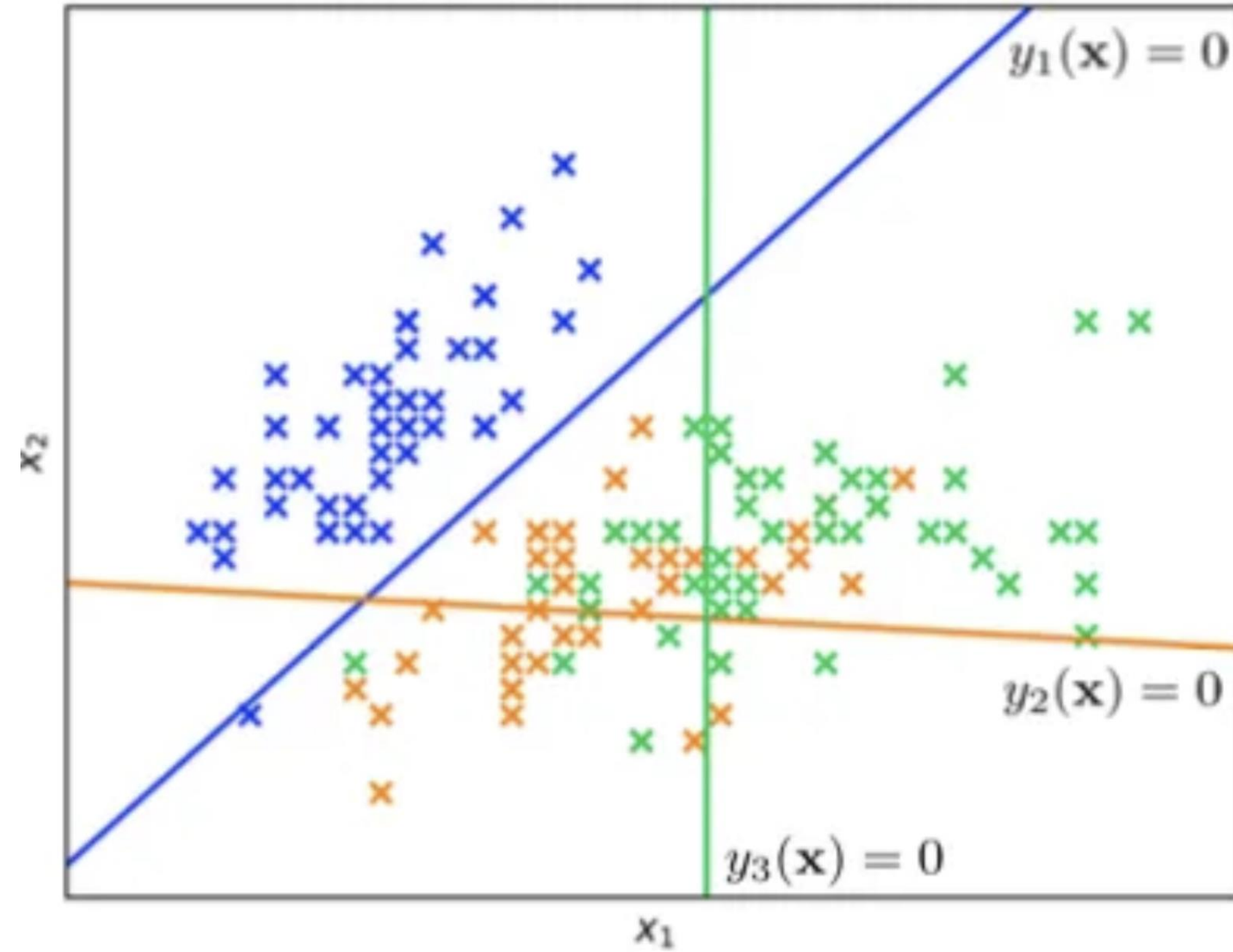
Multi-Class Classification

Hierarchical Classification

- How will you approach Clustering?
 - Grouping class condition densities belonging to one group that are significantly different from the other group.

Multi-Class Classification

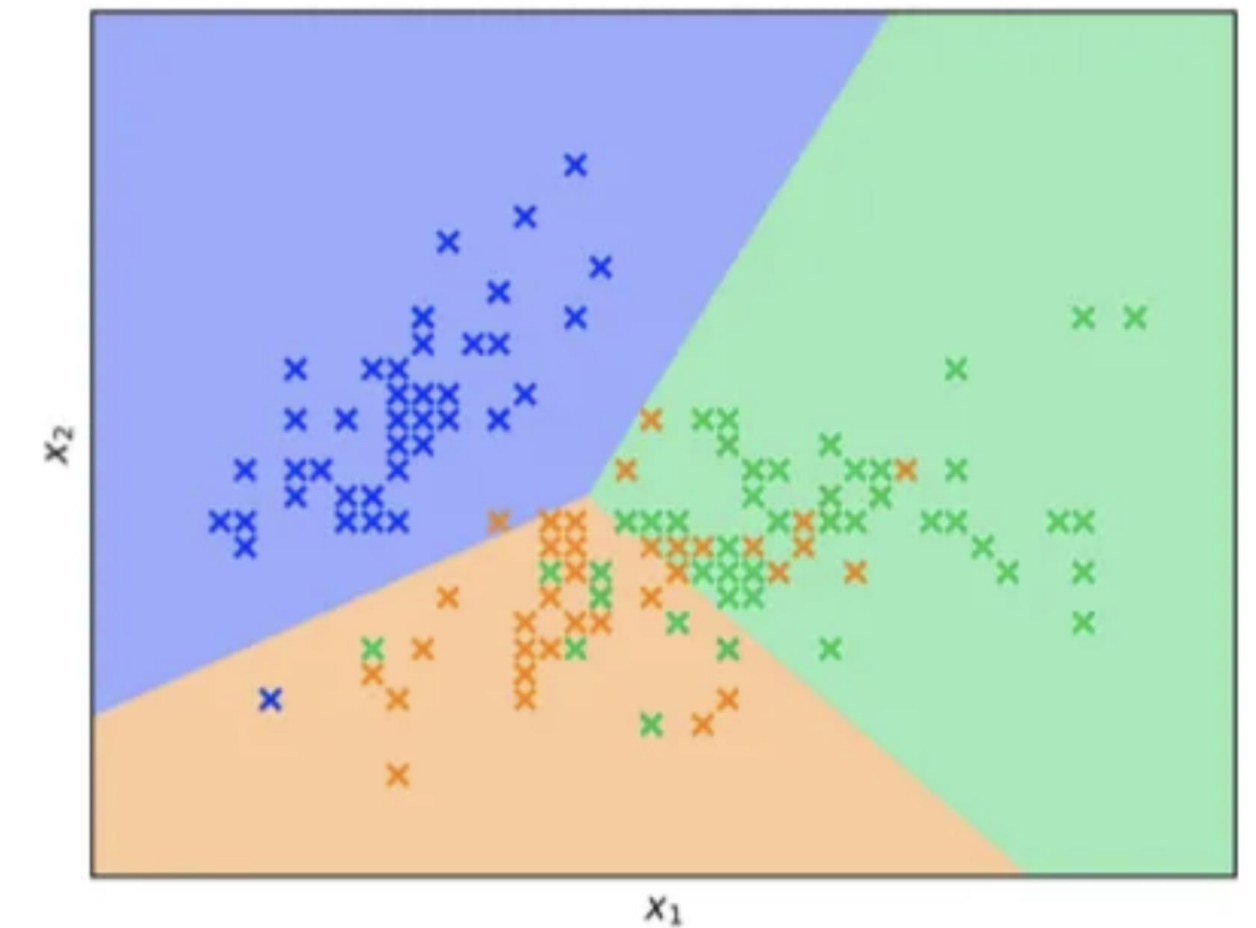
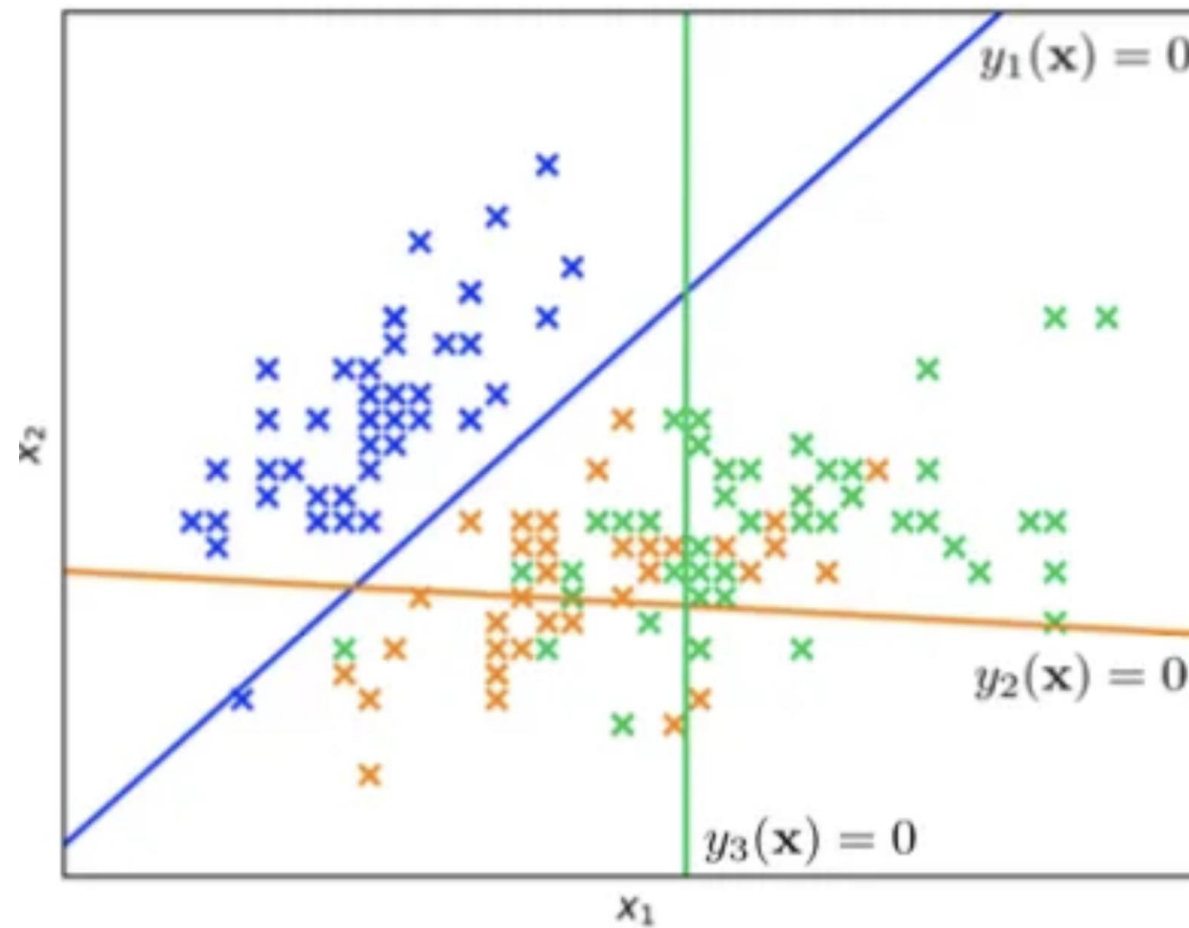
1 v/s ALL



Multi-Class Classification

1 v/s ALL

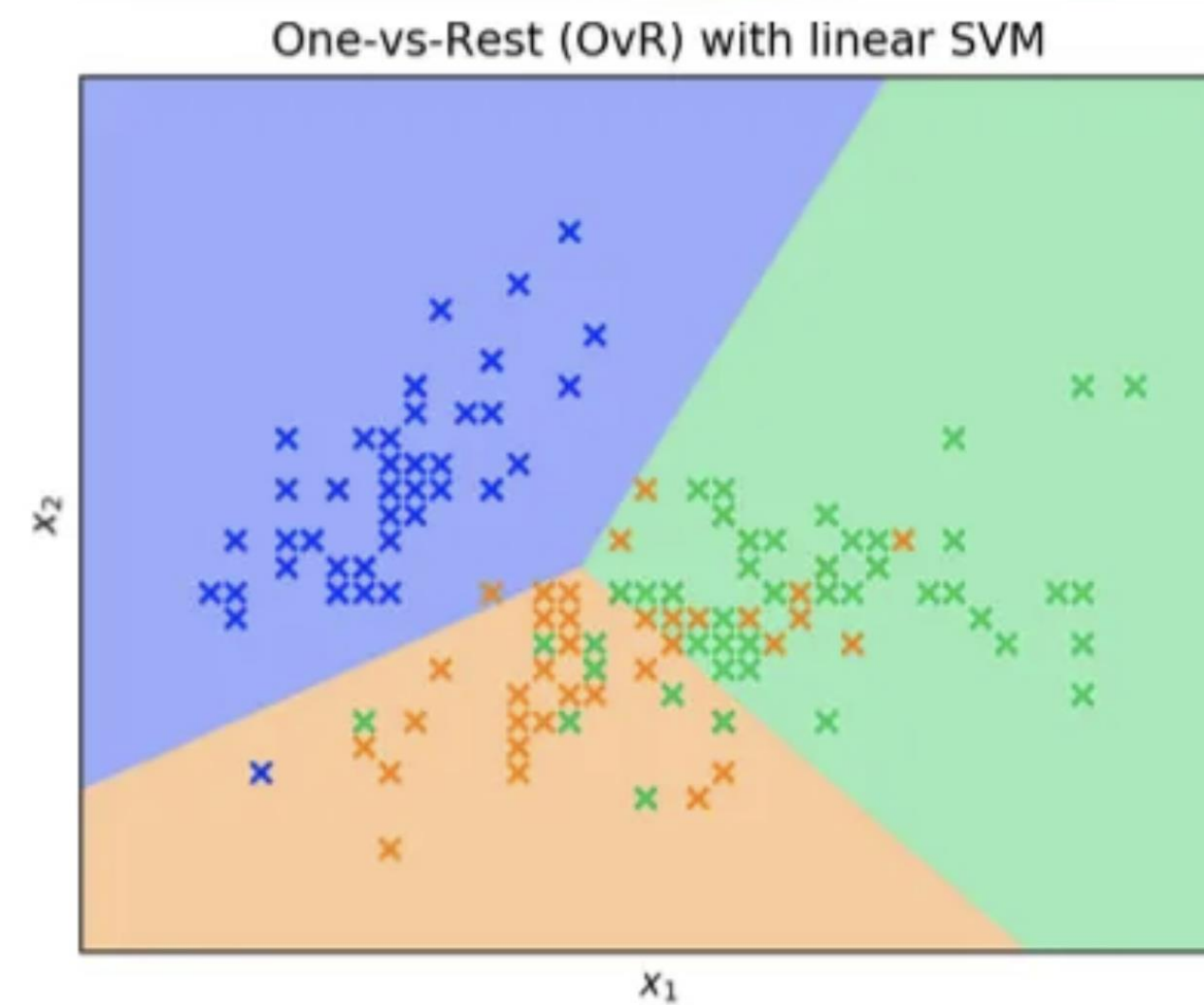
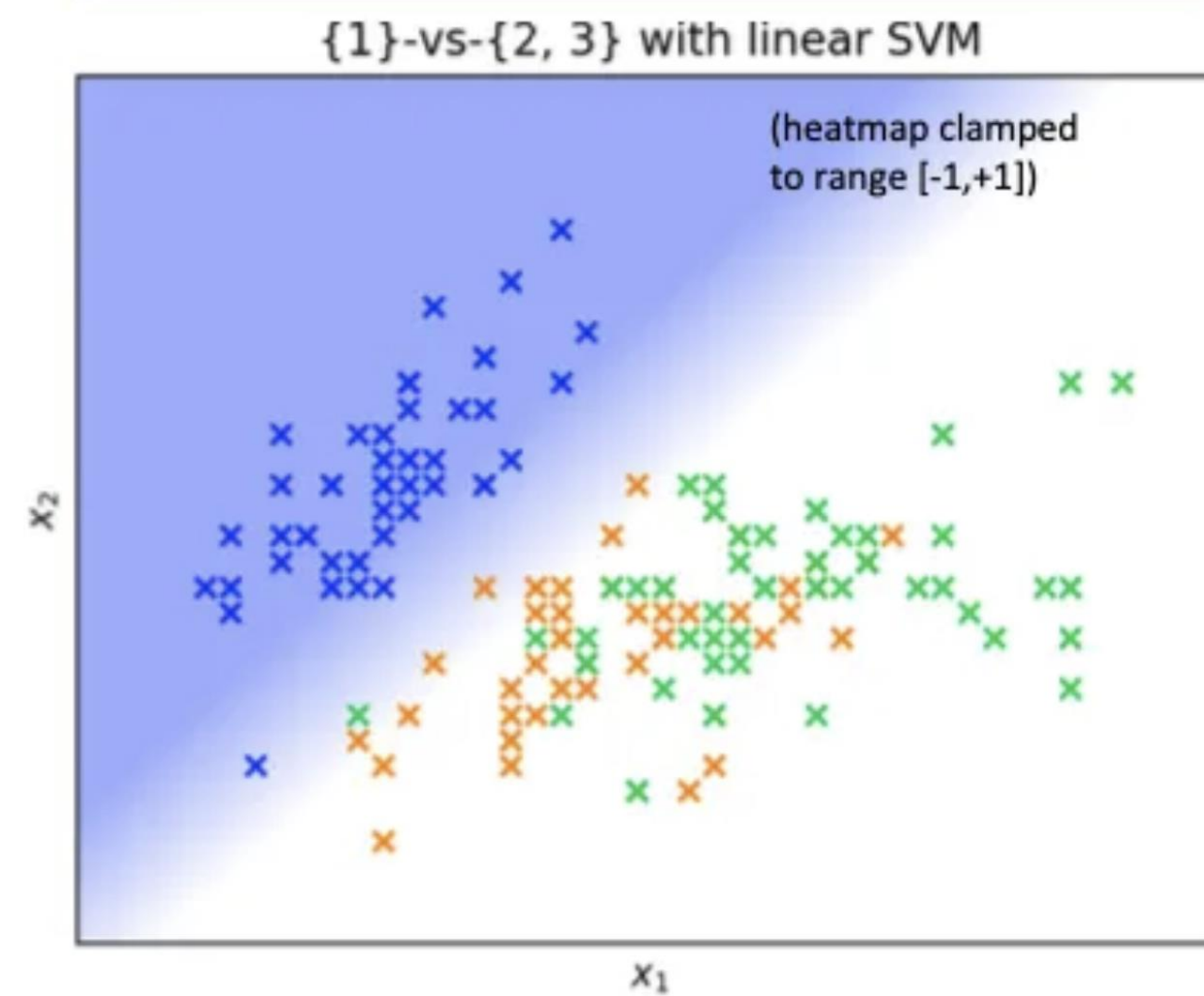
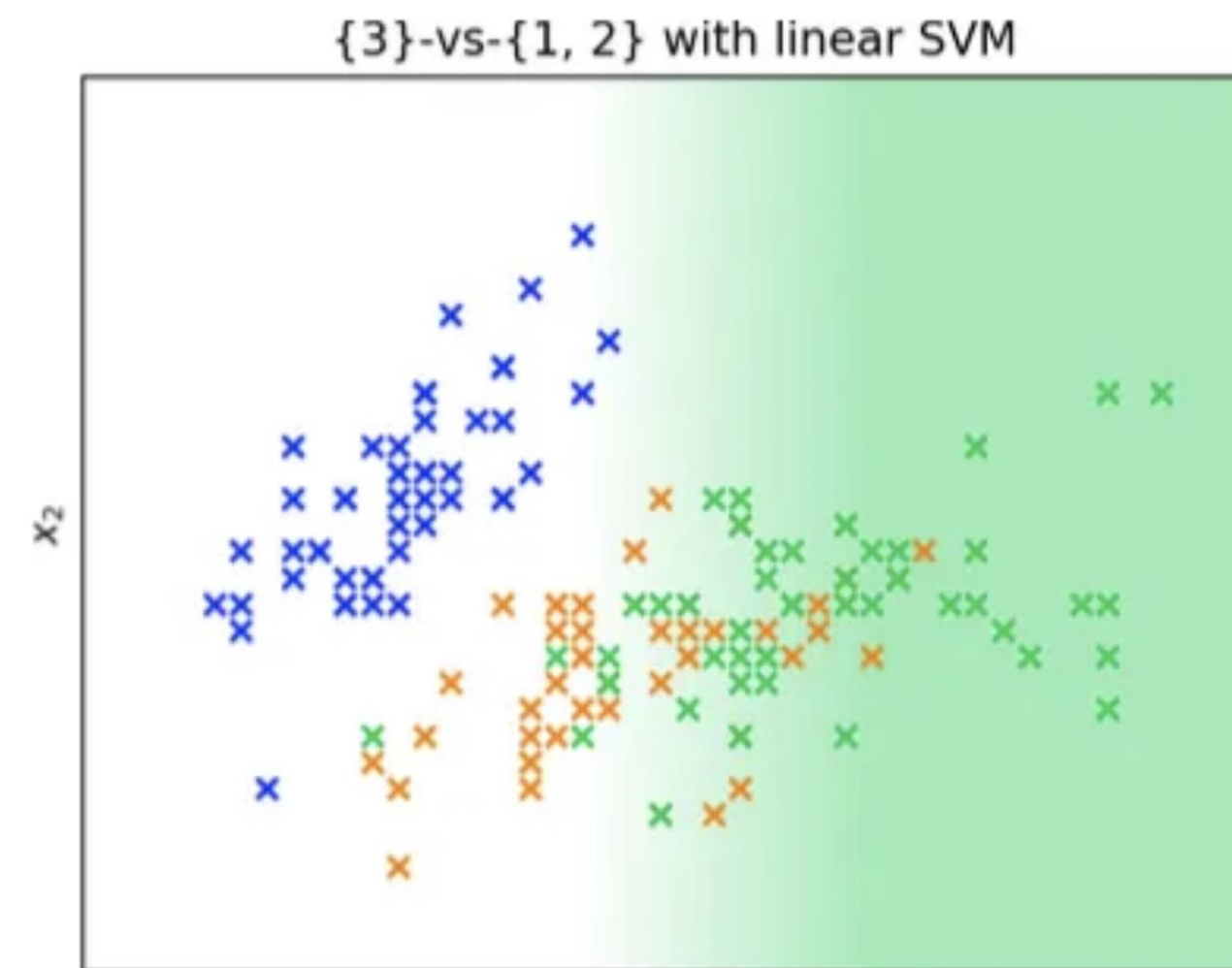
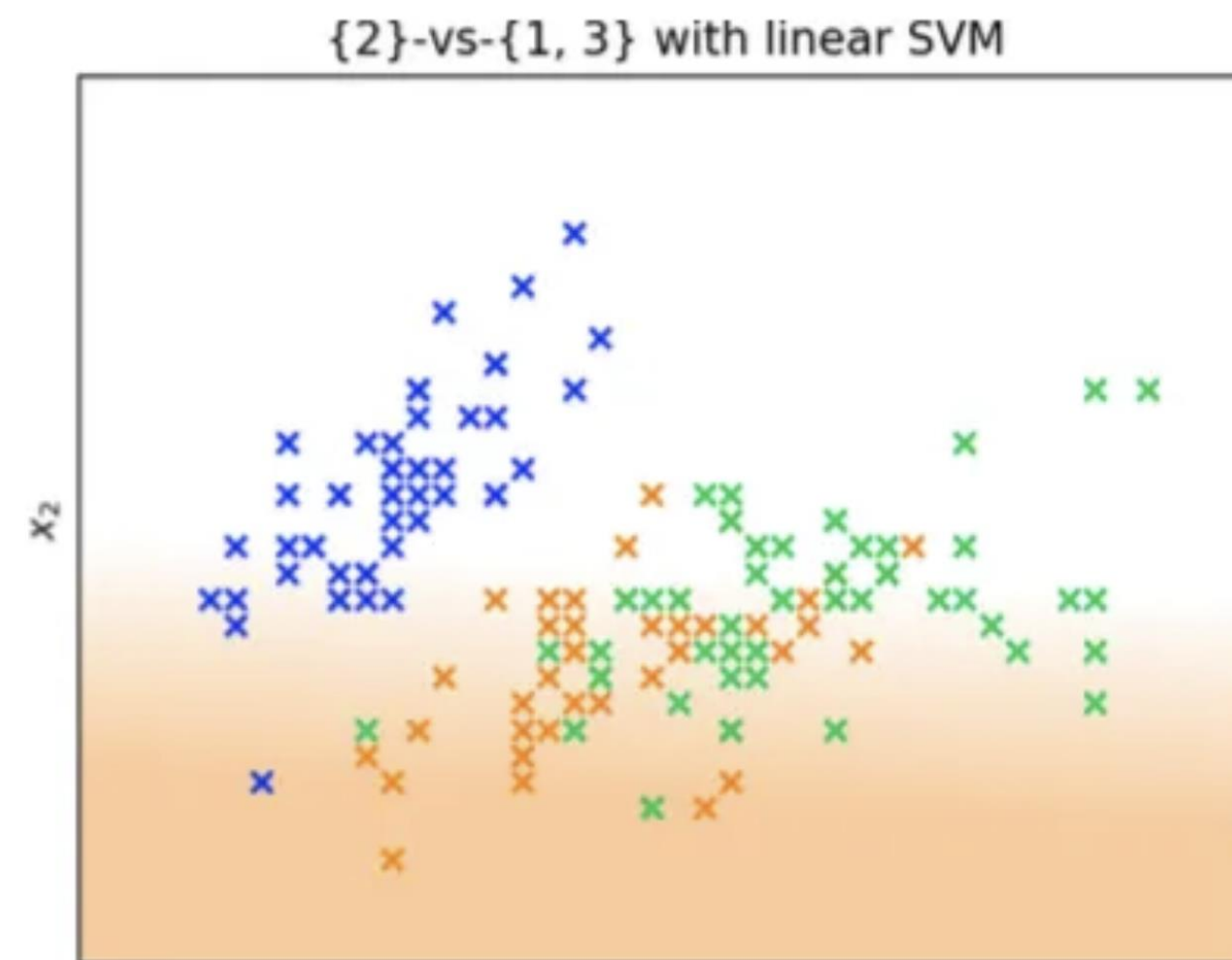
- Three SVMs
 - One for blue
 - One for orange, and
 - One for green class



- Each SVM is trained on binary data, meaning that it's task is to separate its class from all the other classes.

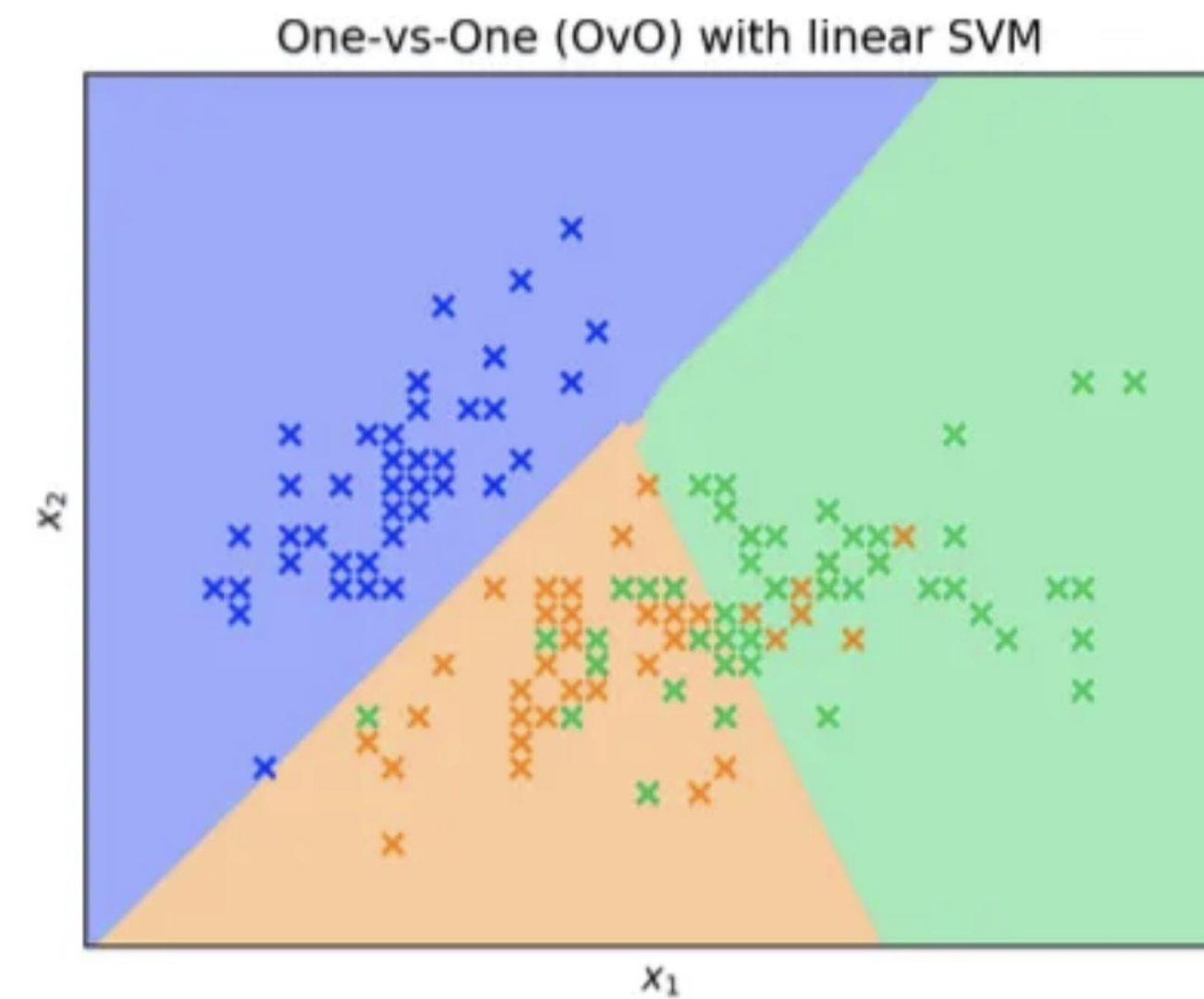
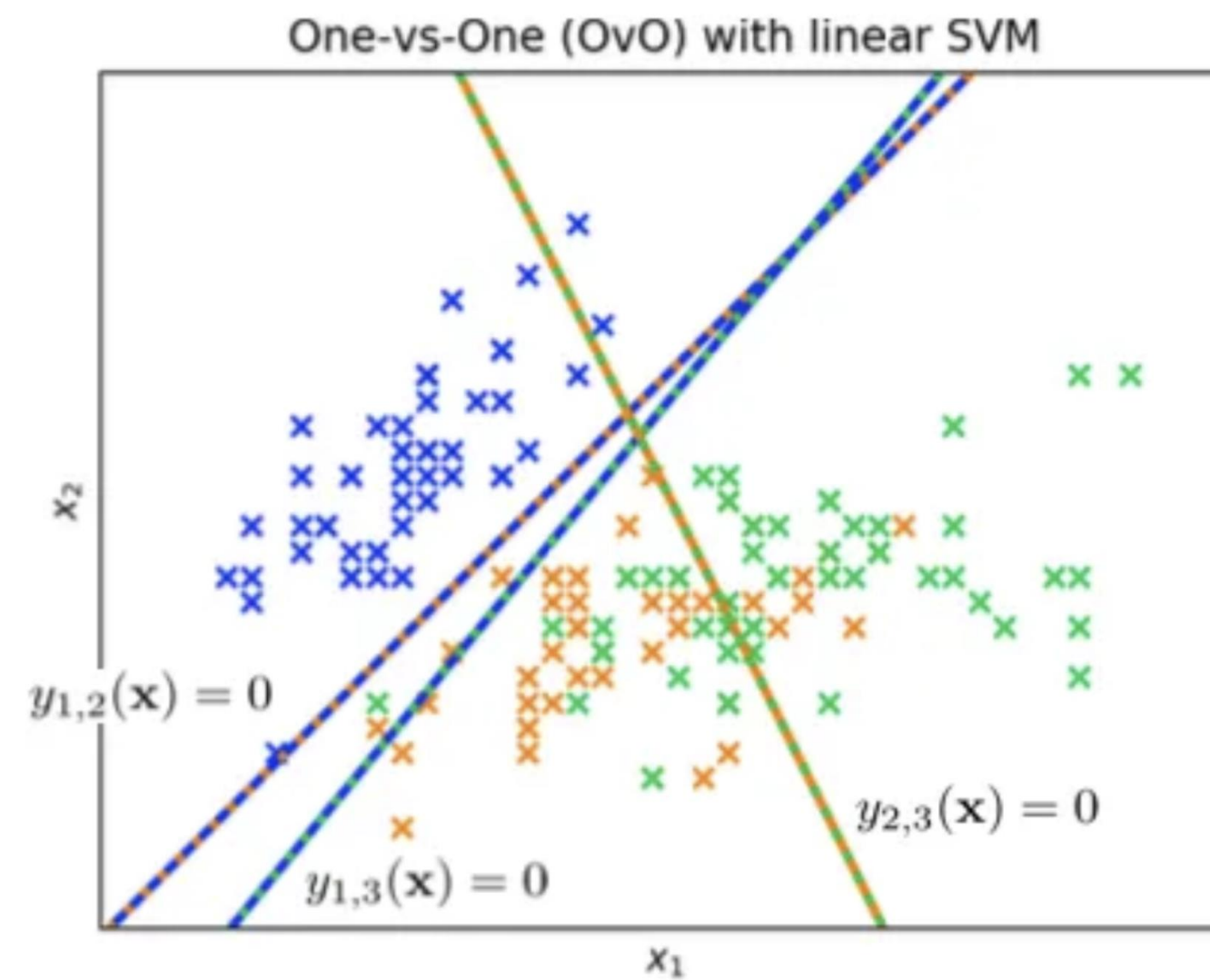
Multi-Class Classification

1 v/s ALL



Multi-Class Classification

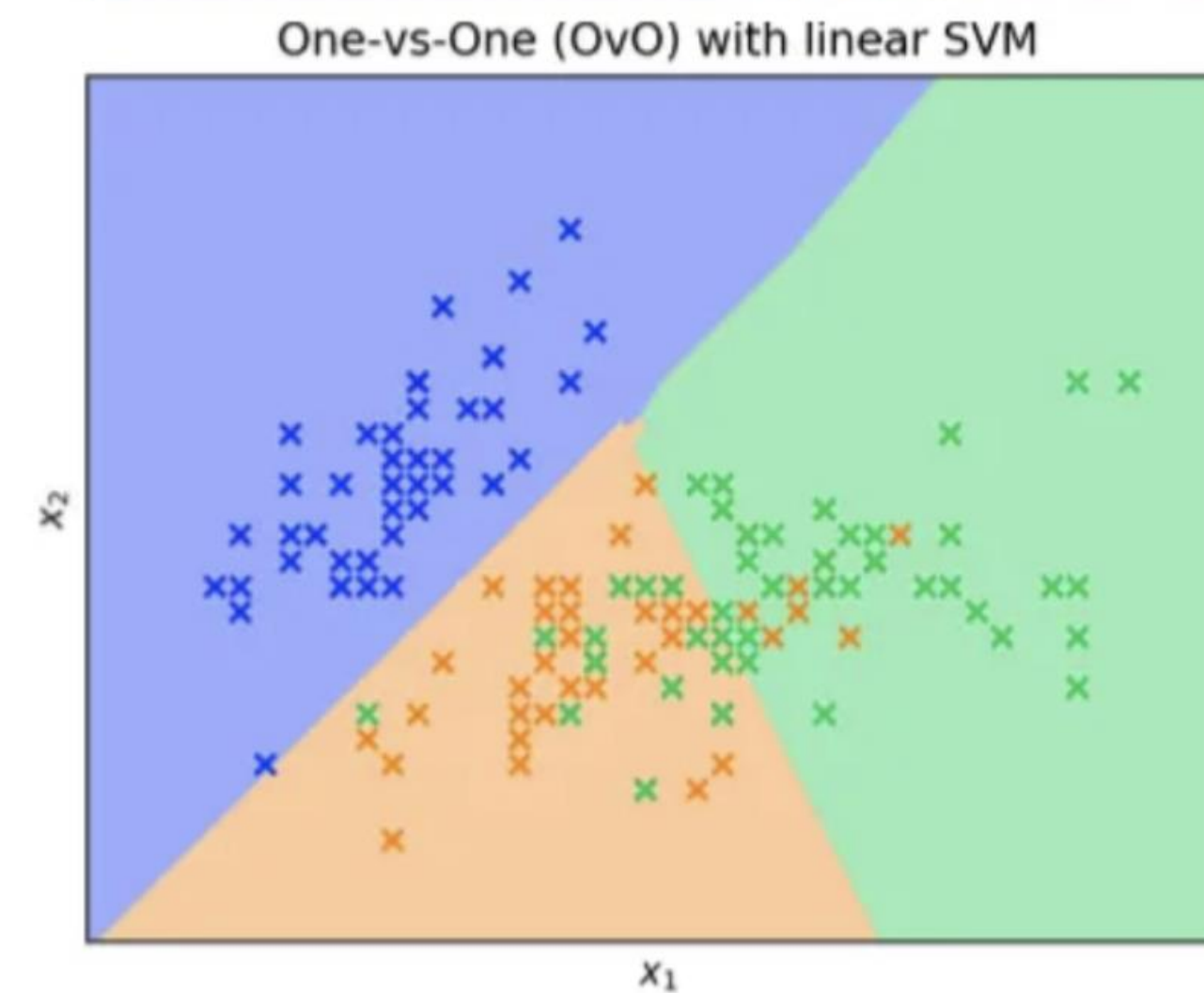
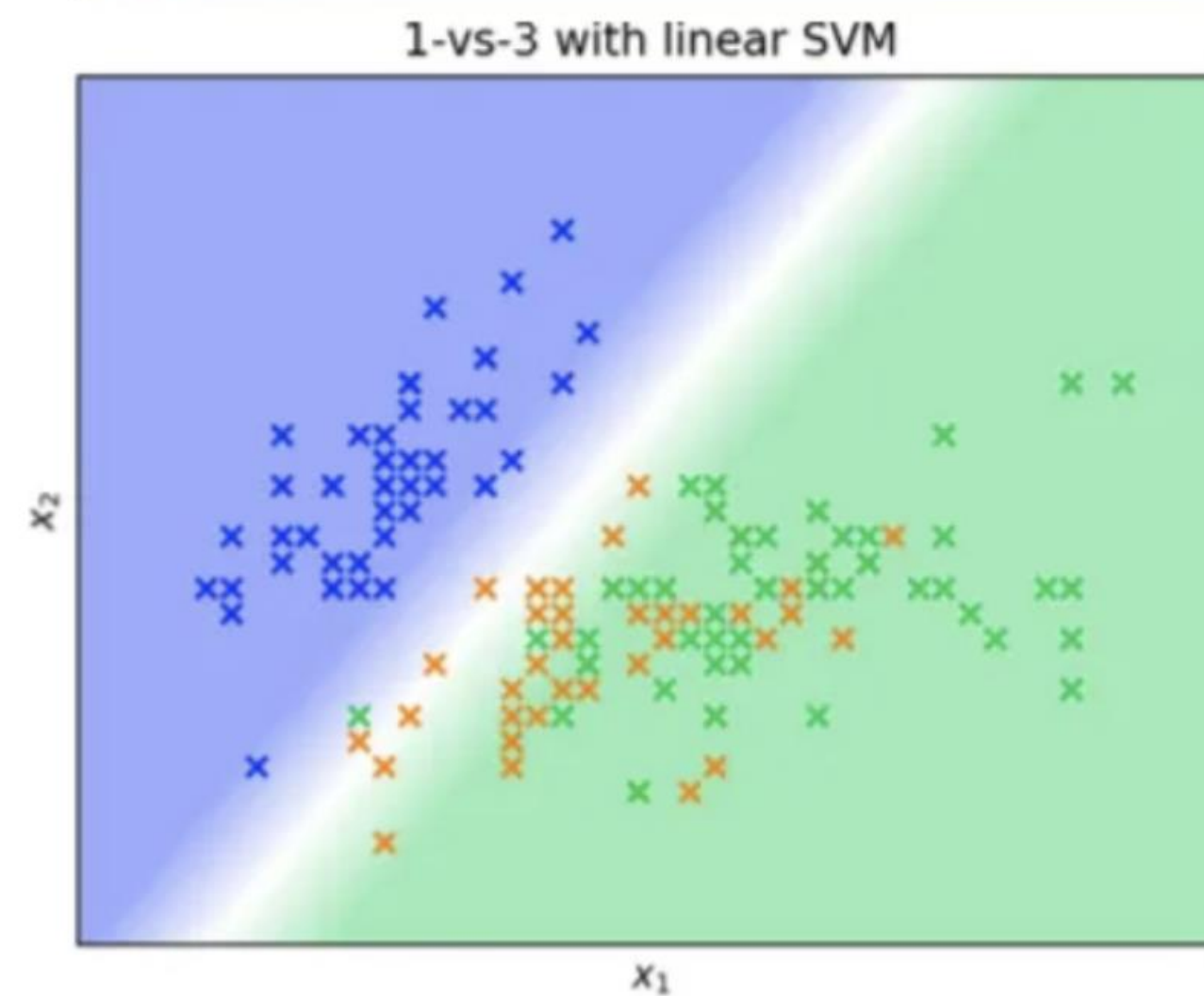
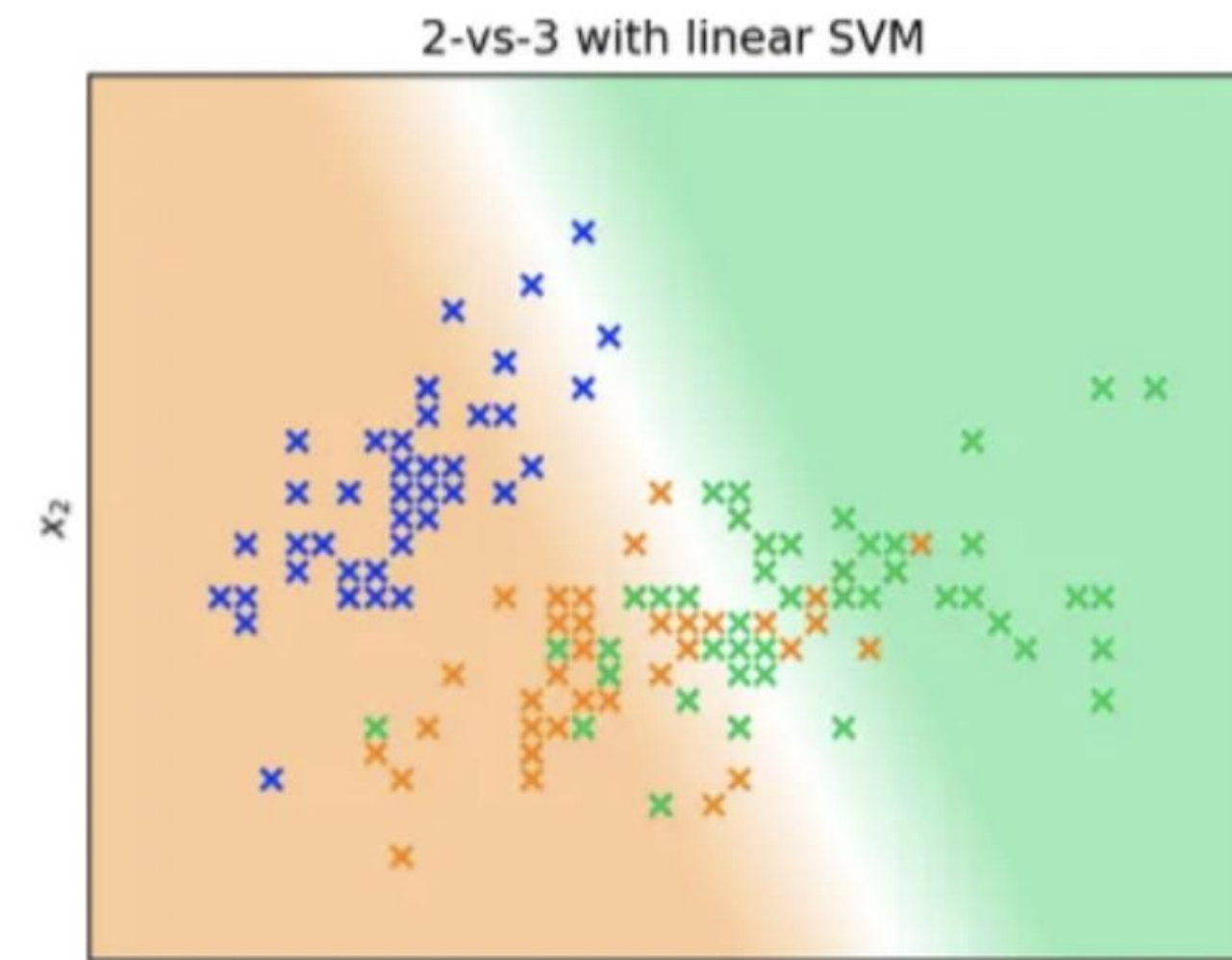
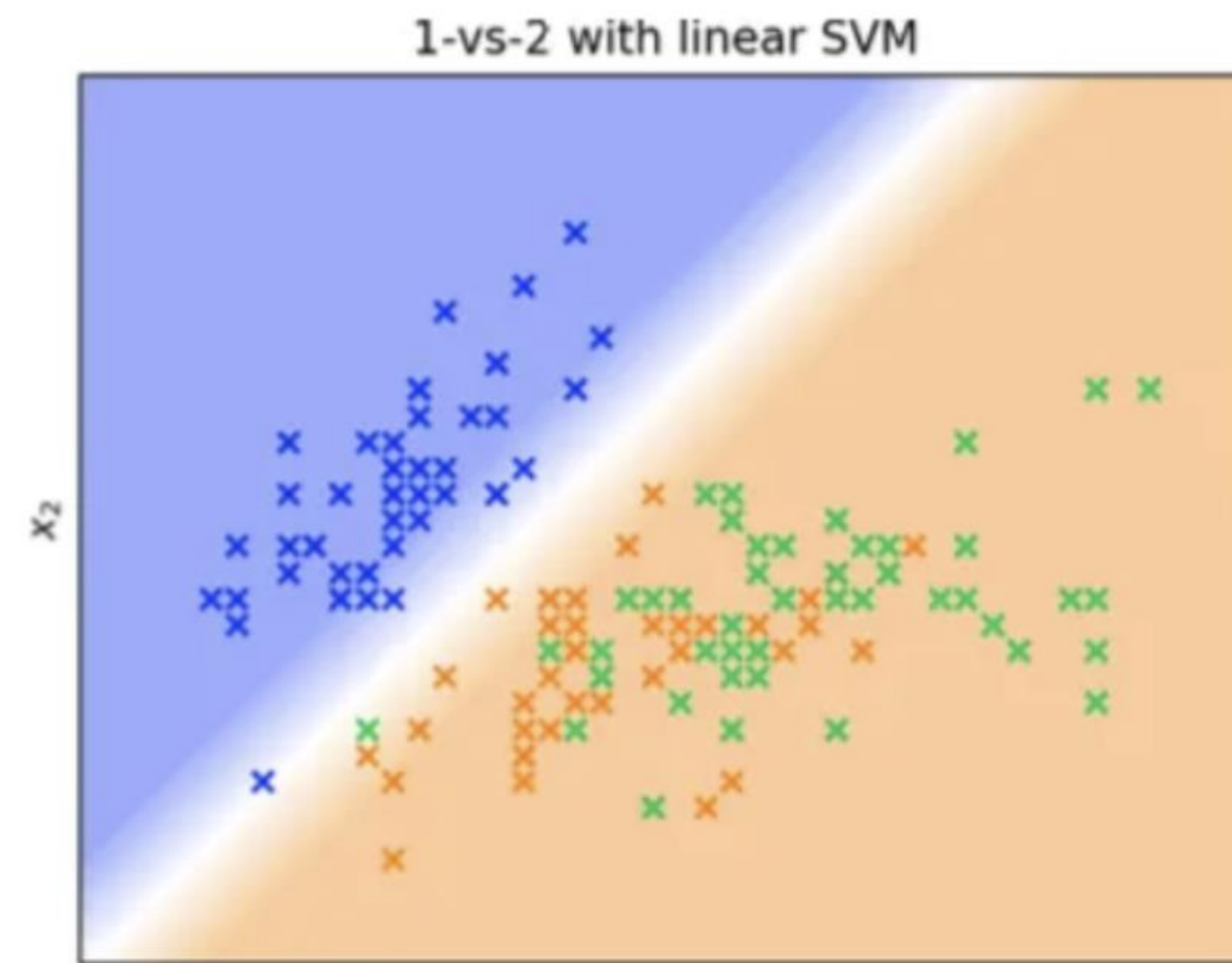
1 v/s 1



- In this setting, instead of training an SVM for each class, we train an SVM for each pair of classes.

Multi-Class Classification

1 v/s 1



Multi-Class Classification

- Issue with both of these methods:
 - Slow Training
 - 1 v/s 1 : Training k SVMs, each on the entire dataset.
 - 1 v/s ALL: Training k^2 SVMs, but each on a fraction of the dataset.