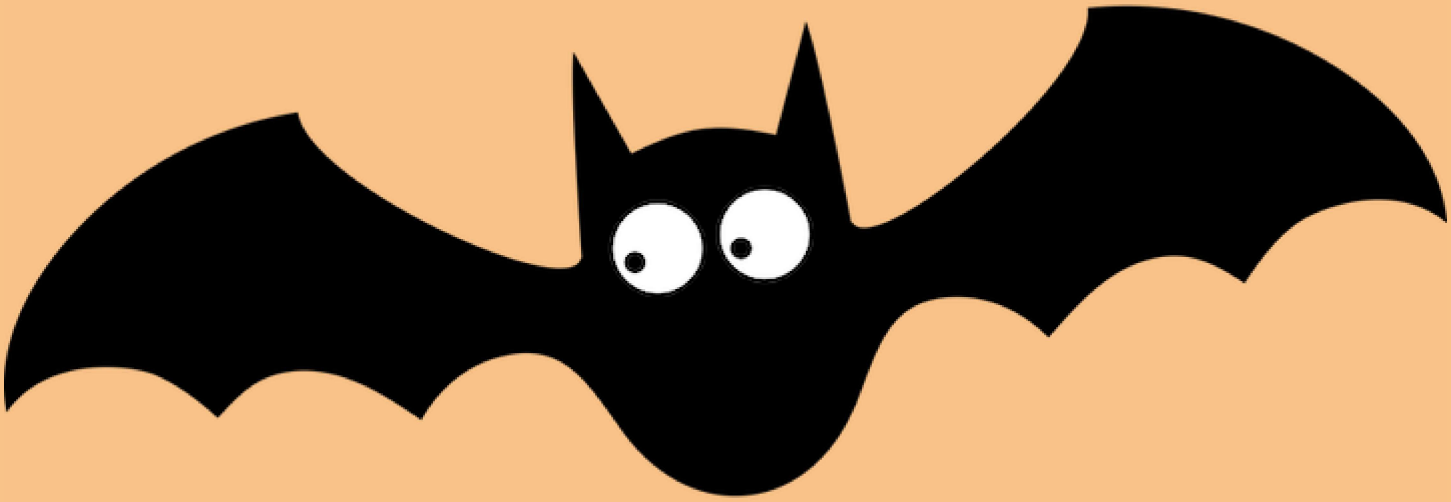

# Ensemble Method and Boosting

Son Nguyen

# Netflix Prize

- 1 million USD to any one that can improve Netflix's rating algorithm...

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- 1 million USD to any one that can improve Netflix's rating algorithm **by 10%**

# Netflix Prize

- **The winning team:**

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# Netflix Prize

- **The winning team:** BellKor's Pragmatic Chaos, used **ensemble models**"
- **The second-place team's name** is "The Ensemble"

# Netflix Prize

- "During the nearly 3 years of the Netflix competition, there were two main factors which improved the overall accuracy:
    - The quality of the individual algorithms, and
    - the **ensemble idea**"

# Ensemble Success

> "XGBoost (an ensemble algorithm) is an algorithm that has recently been dominating applied machine learning and Kaggle competitions for structured or tabular data." Link

# Ensemble Success

> Adaboost (an ensemble algorithm) won 2003 **Godel Prize**: AdaBoost demonstrated novel possibilities in analysing data and is a permanent contribution to science even beyond computer science. Link

# Ensemble Success

> AdaBoost (with decision trees as the weak learners) is often referred to as the best out-of-the-box classifier. Link

# Ensemble Success

> Leo Brieman, who invented "Bagging" and "Random Forest" crowned AdaBoost the "best off-the-shelf classifier in the world (2000).

# Ensemble Machine Learning Approach

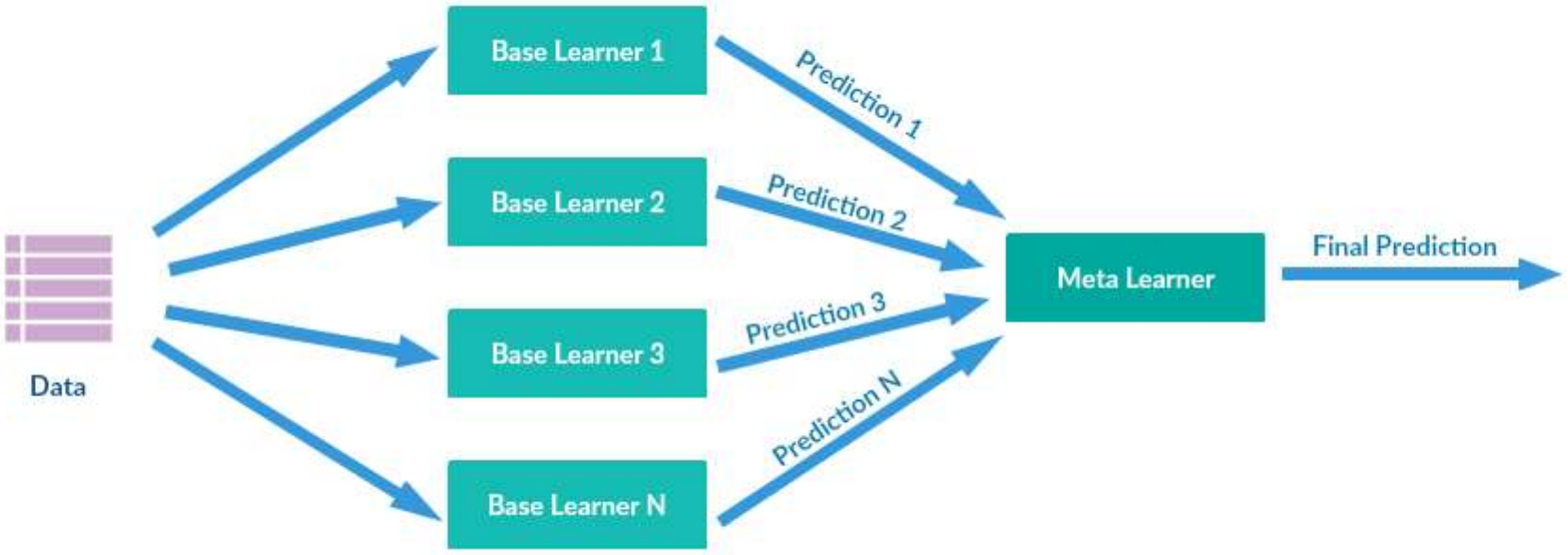
- An ensemble is a composite model, combining a series of low performing **classifiers**(classification models) or **learners** with the aim of creating an improved classifier.

# Ensemble Machine Learning Approach

- An ensemble is a composite model, combining a series of low performing **classifiers**(classification models) or **learners** with the aim of creating an improved classifier.
- Three common ensemble:
  - Stacking
  - Bagging
  - Boosting

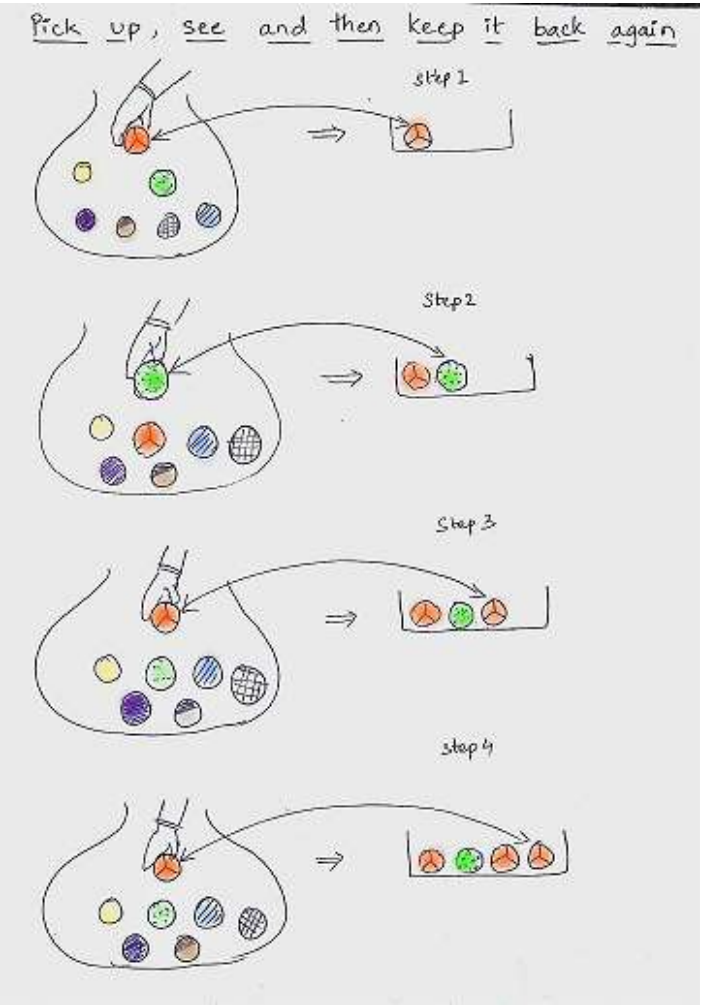
# Stacking

- Stacking combines multiple base learners predictions into a new data set.
- This new data are treated as the **input data** for another learner (meta learner).



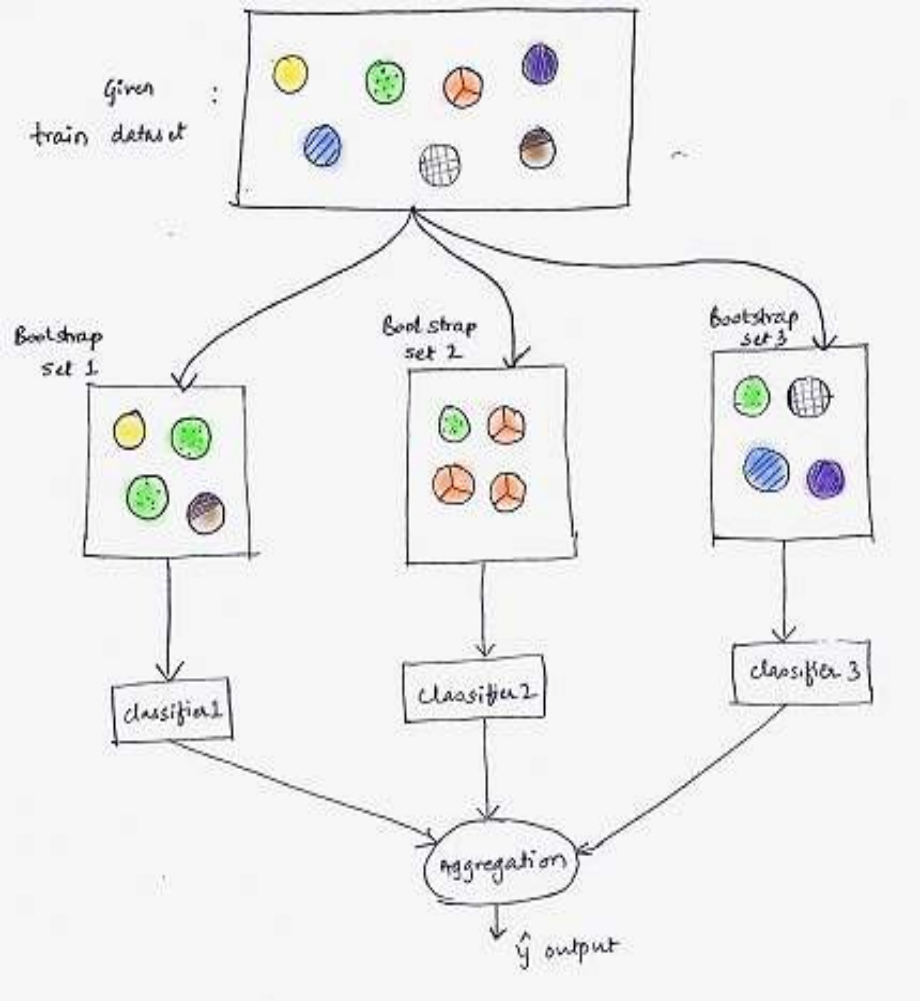
# Bagging = Bootstrap Aggregating

- Step 1: Boostrapping



# Bagging = Bootstrap Aggregating

- Step 2: Aggregating



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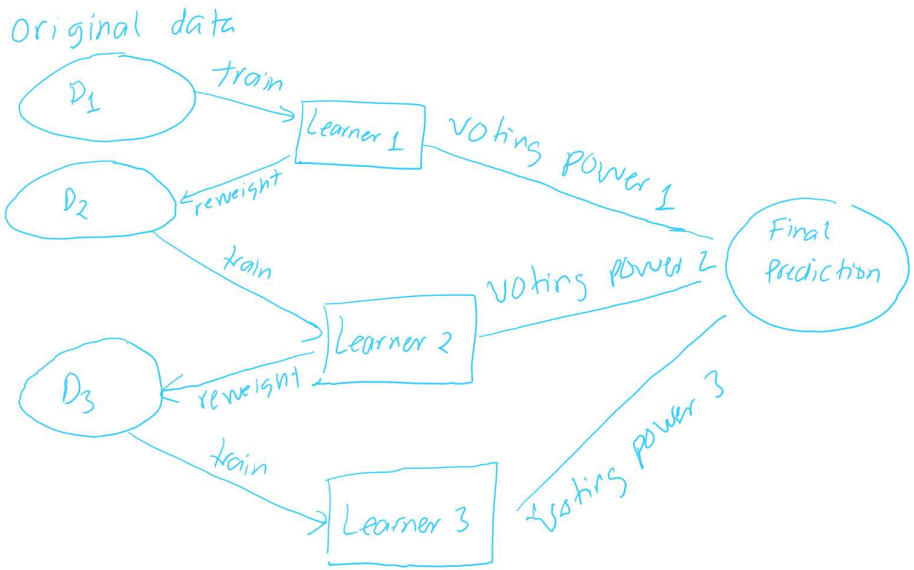
- Weak learners are sequentially converted into a strong learner.



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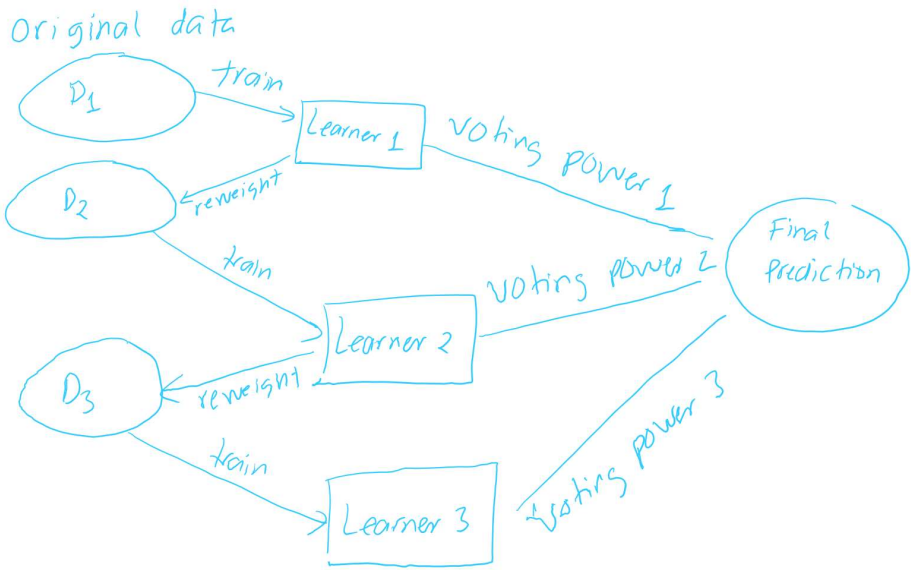
- Each leaner in the sequence tries to correct its predecessor.



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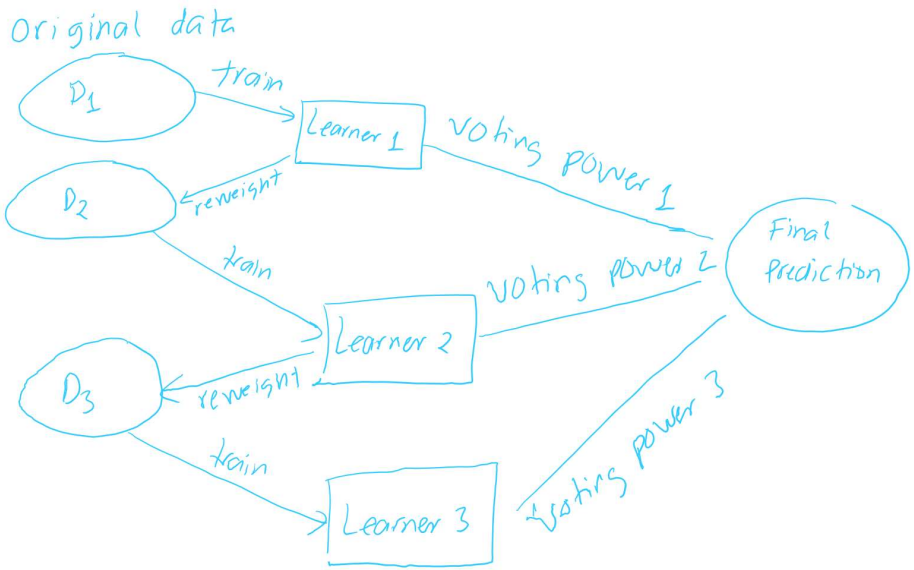

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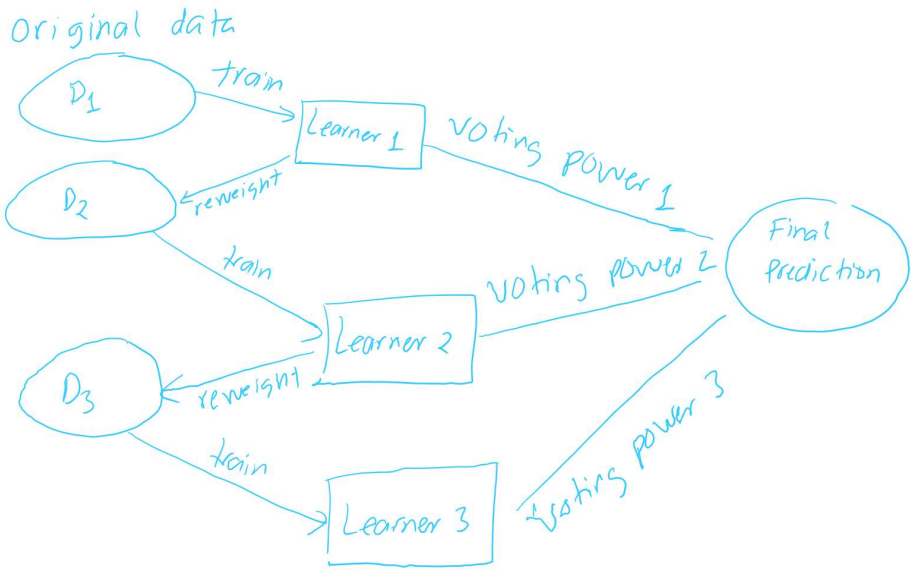

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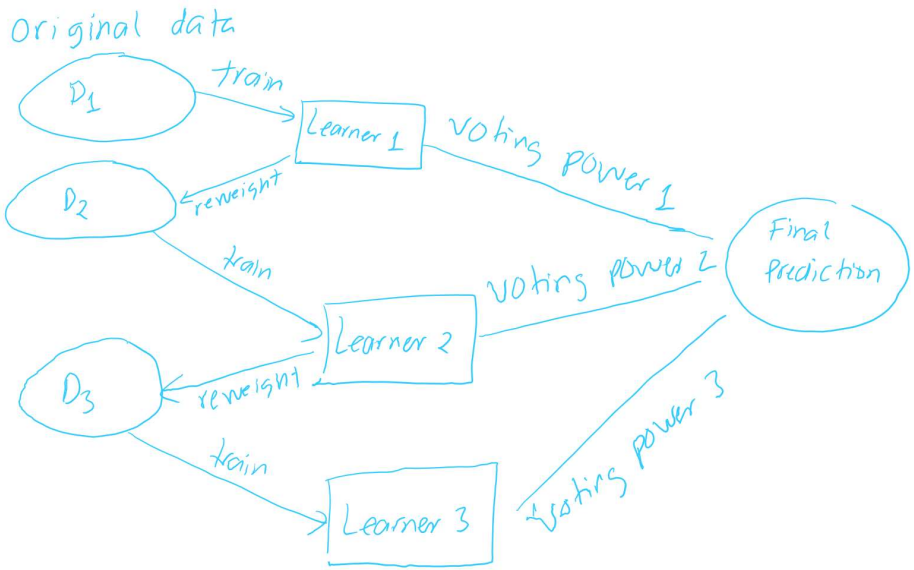
- In D2, the wrong misclassified of Learner 1 gets higher weights.
- In D3, the wrong misclassified of Learner 2 gets higher weights.



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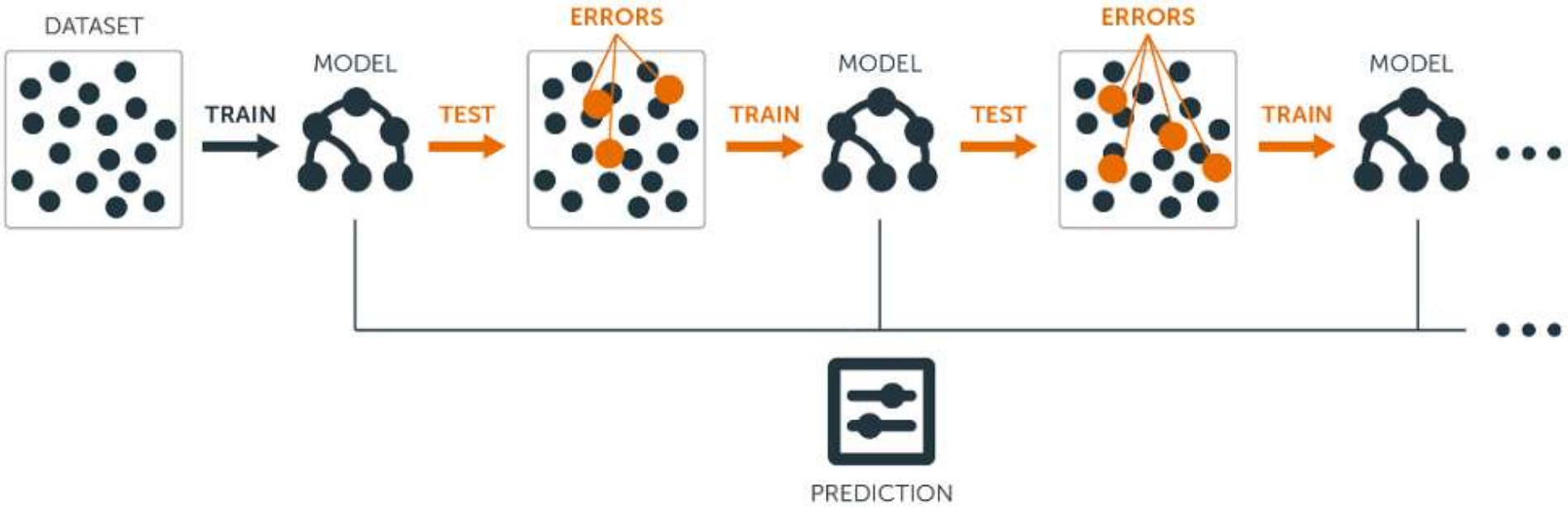
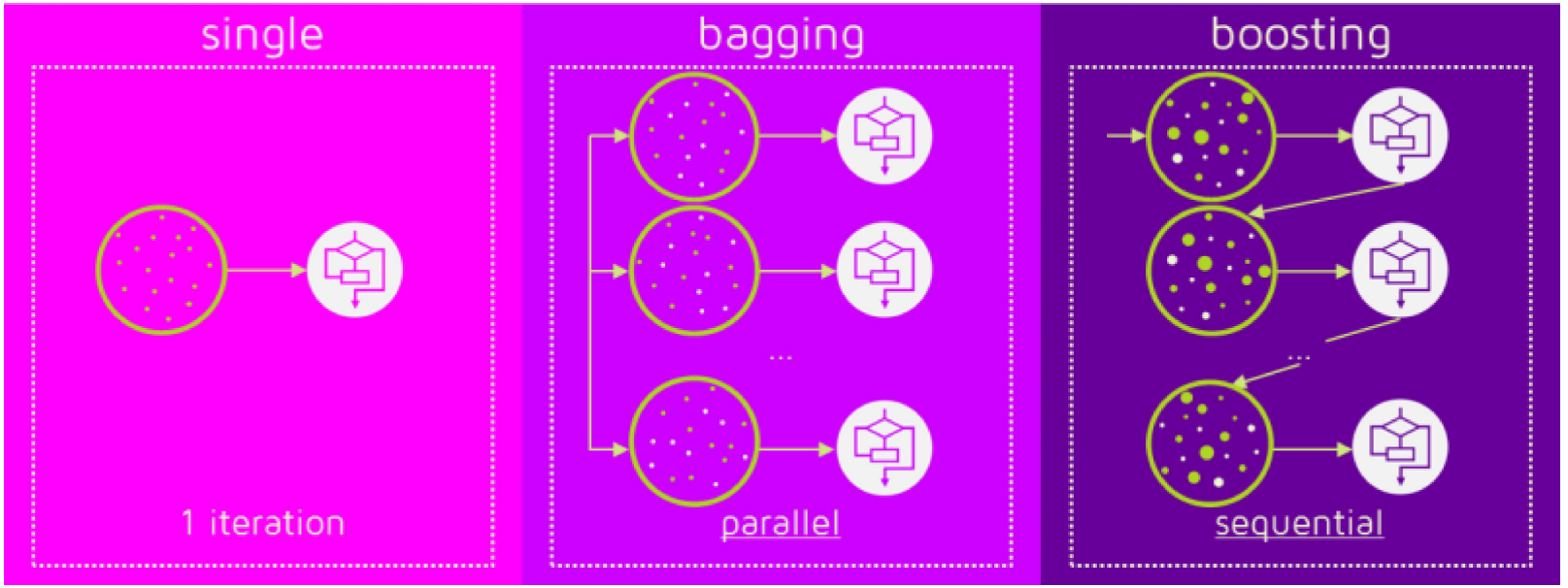

DATASET
TRAIN
MODEL
TEST
ERRORS
TRAIN
MODEL
TEST
ERRORS
TRAIN
MODEL
PREDICTION

# Bagging vs. Boosting



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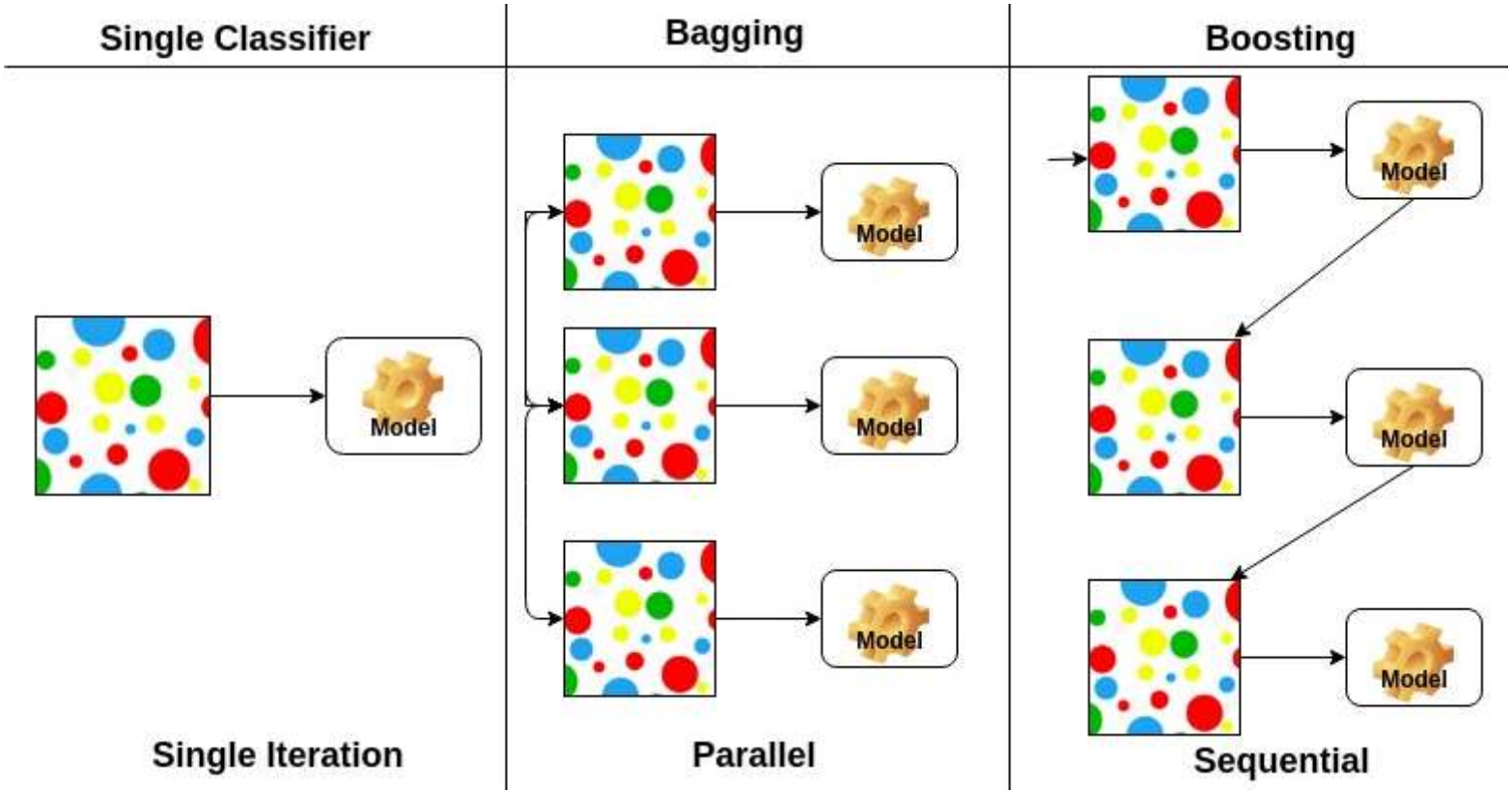

# Types of Boosting

- Adaboost
- Gradient Boosting

# Adaboost

## Idea Behind Ada Boost

- Examples of high weight are shown more often at later rounds
- Face/nonface classification problem:

### Round 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1/7 | 1/7 | 1/7 | 1/7 | 1/7 | 1/7 | 1/7 |
| best weak classifier: | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✗ |
| change weights: | 1/16 | 1/4 | 1/16 | 1/16 | 1/4 | 1/16 | 1/4 |

### Round 2

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| best weak classifier: | ✓ | ✓ | ✓ | ✗ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ |
| change weights: | | 1/8 | 1/32 | 11/32 | | 1/2 | | 1/8 | 1/32 | 1/32 |

# Adaboost

## Idea Behind Ada Boost

### Round 3

- out of all available weak classifiers, we choose the one that works best on the data we have at round 3
- we assume there is always a weak classifier better than random (better than 50% error)
- image is half of the data given to the classifier
- chosen weak classifier **has to** classify this image correctly

# Adaboost, Clearly Explained

- Demonstration by StatQuest
- Link