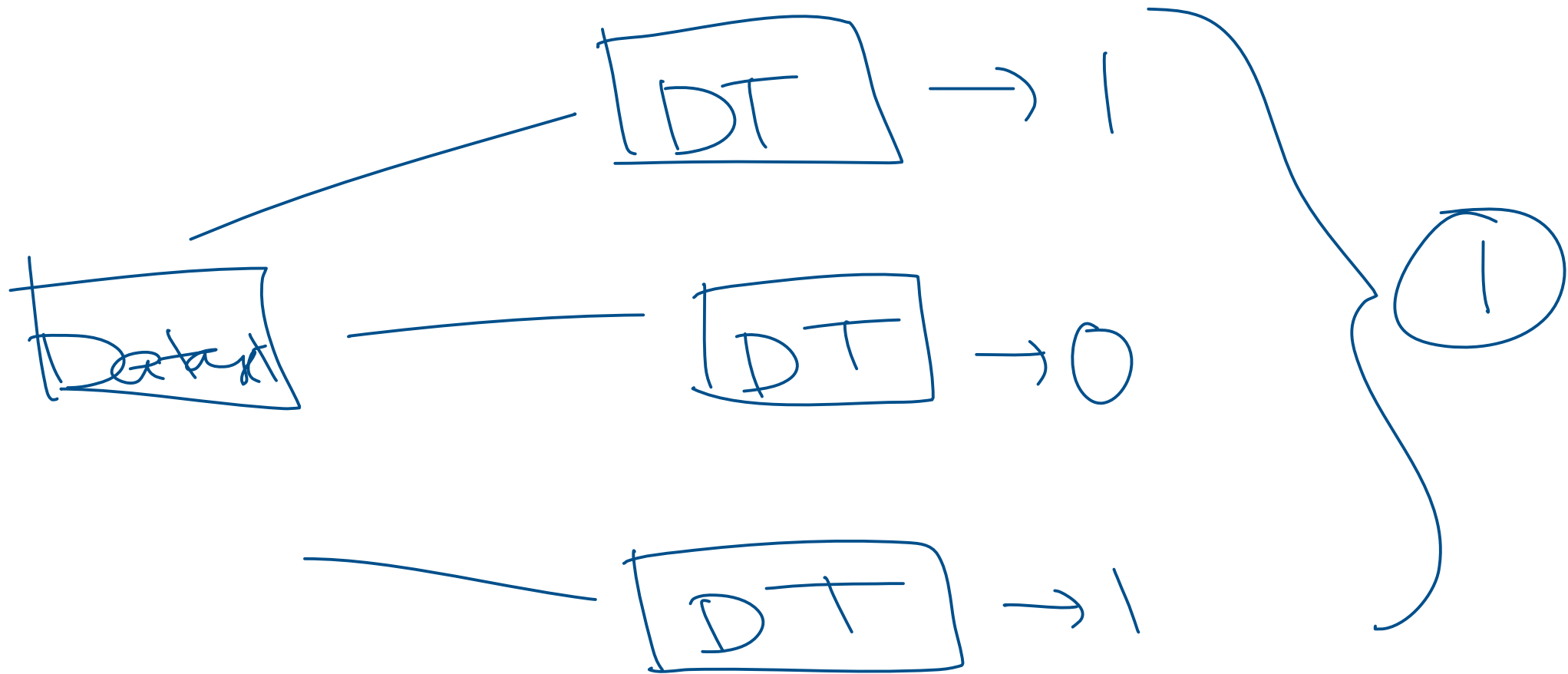


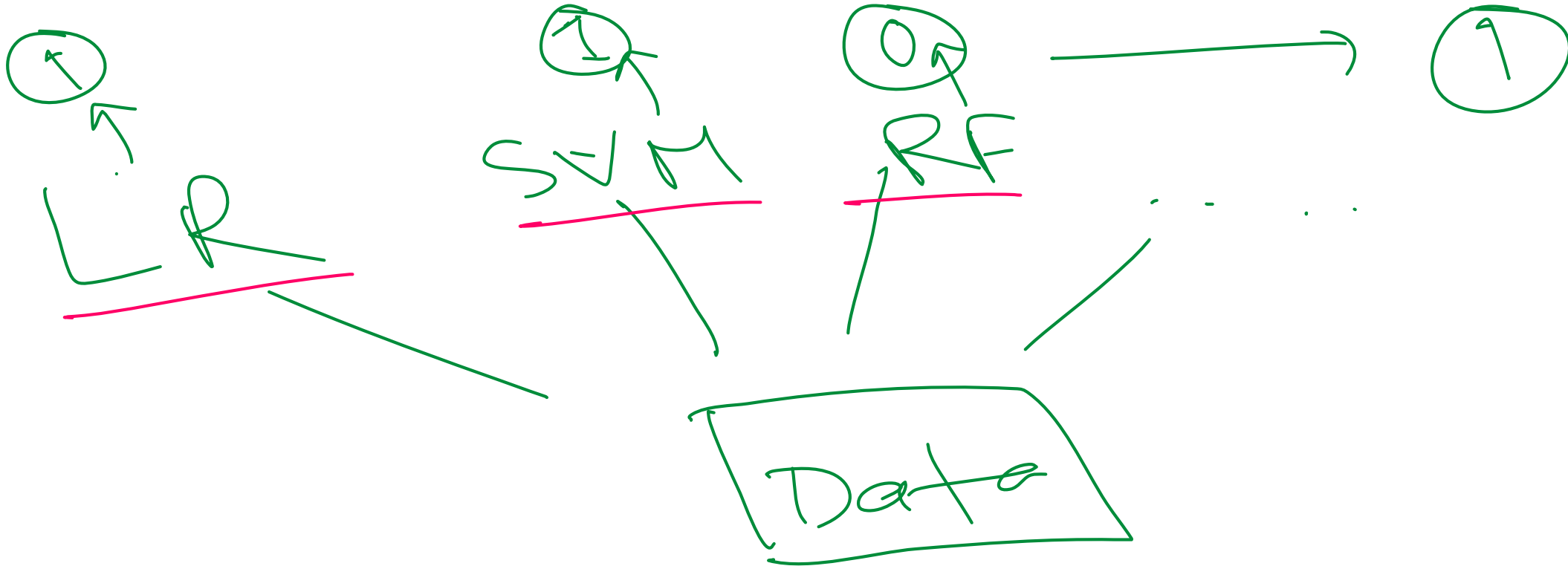
# Ensemble Learning

- wisdom of the crowd
- Group of predictors  
    → ensemble



# Voting classification

- classifiers  $\rightarrow$  80%



- Hard voting

- Weak learners

Coin  $\rightarrow$  51% biased  
(Head)

$\rightarrow$  49% Tail

1000 toss  $\rightarrow$  510 H

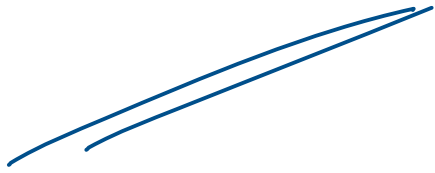
$\rightarrow$  490 T

1000  
Majority

of  $H = 75\%$

10K

→ 97%



Law of large numbers

0

1000 classifiers

51%

49%

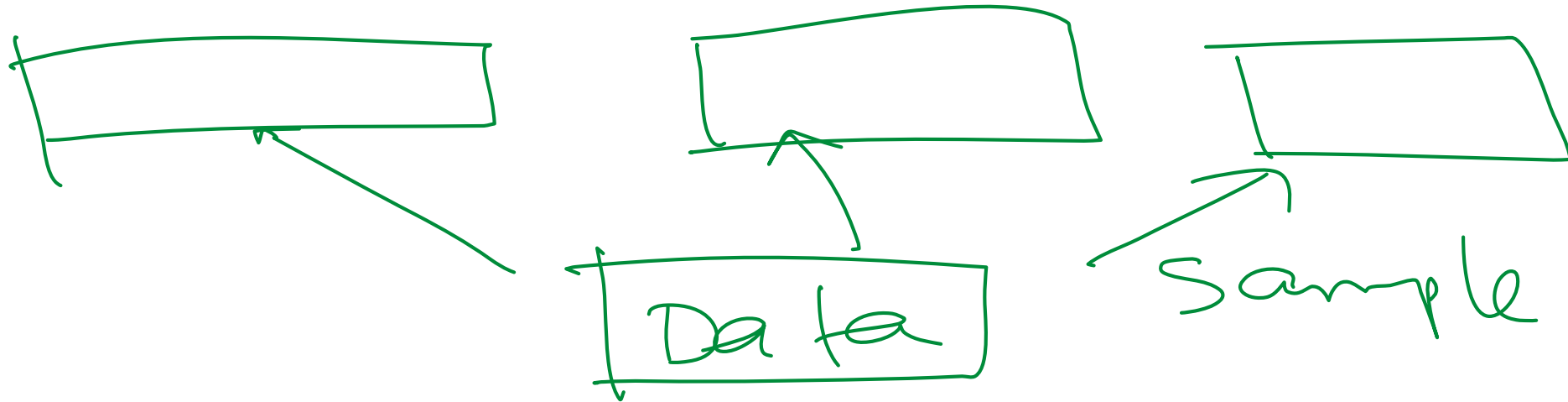
∴ 75% accurate

10k classifications → 97% accuracy



# Bagging

- replacement
- random sampling



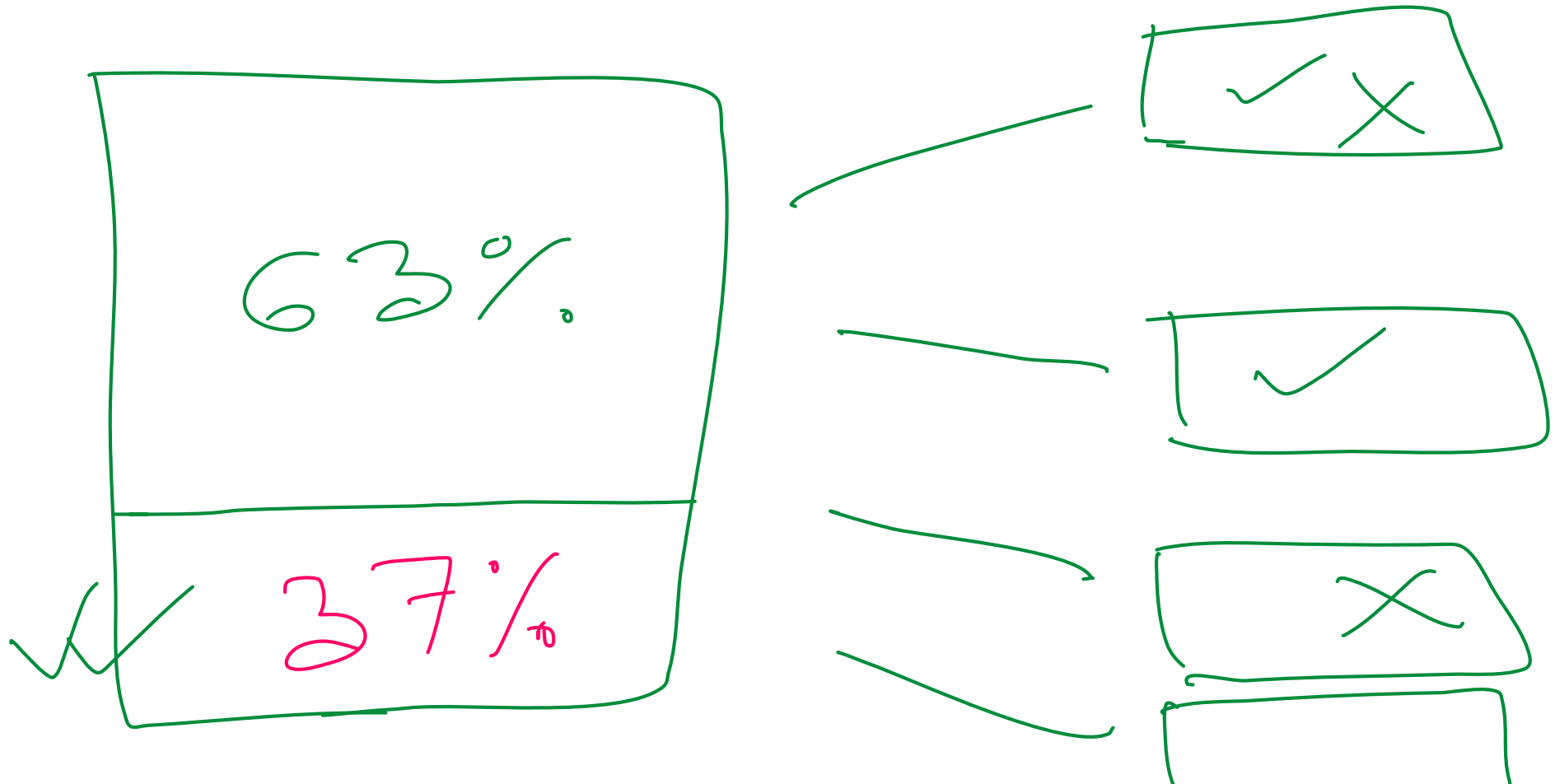
Pasting

— without

replacement

- Soft voting
- individual prediction
  - ↳ high bias
- aggregation
  - ↳ low bias
  - ↳ lower variance

# Out of Bag Evaluation



\_\_\_\_\_

✓ [\_\_\_\_\_]

Dataset

Train

Test

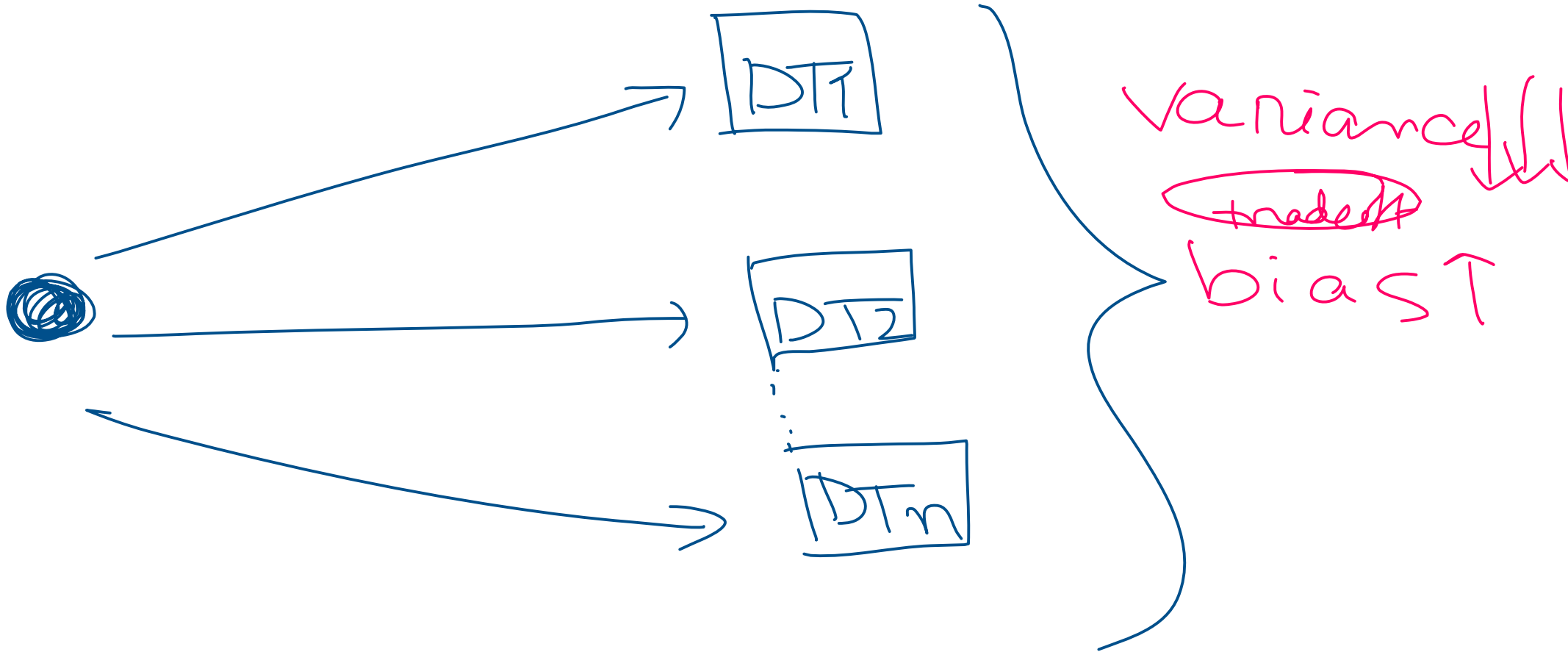
63%

37%

Train

Validation

# # Random Forest



✓



# Extra Trees

- Extremely Randomized  
Trees



Feature Importance