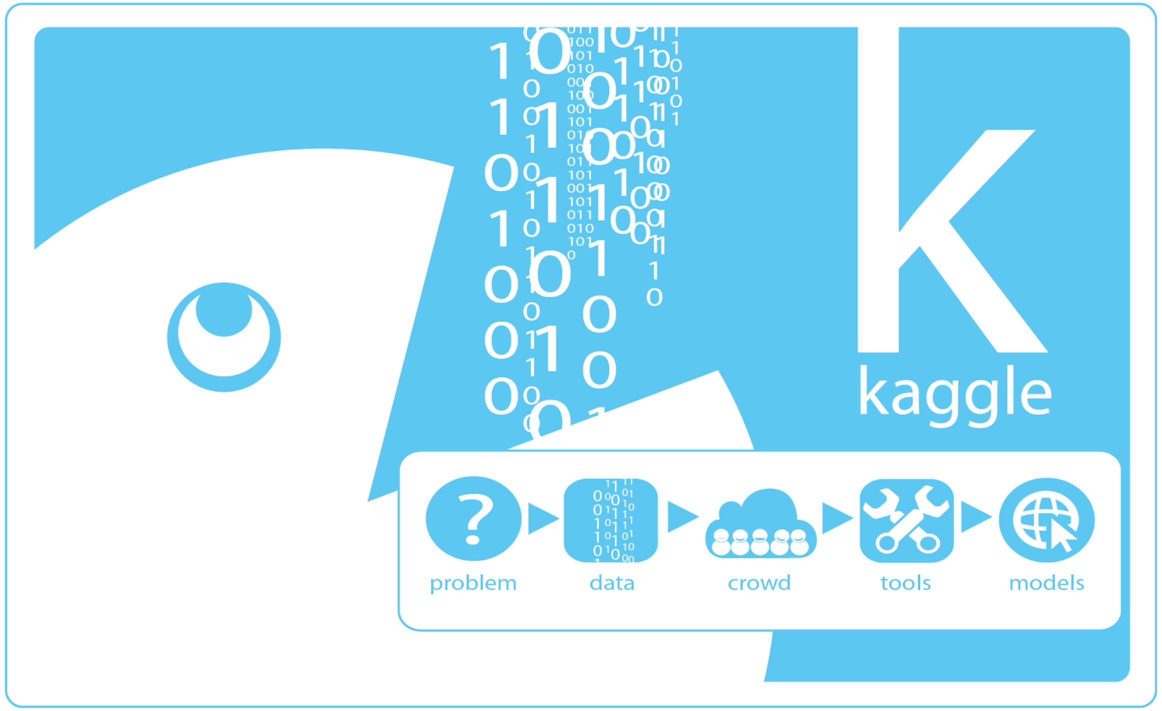
Ensemble Methods

Practicing data science

- Kaggle
- Crowdsourcing the problems that firms face in data analysis



Measuring classification accuracy

- **Accuracy**: the percentage of correct predictions among all predictions

$$\text{Accuracy} = \frac{\#\ \text{Correct}}{\#\ \text{Total}}$$

Measuring classification accuracy

- **Precision**: the percentage of successes that were correctly identified

$$\text{Precision} = \frac{\#\ \text{Predicted True Positives}}{\#\ \text{All True Positives}}$$

Measuring classification accuracy

- **Recall**: the percentage of predicted successes that were actually successes

$$\text{Recall} = \frac{\#\ \text{Predicted True Positives}}{\#\ \text{All Predicted Positives}}$$

Measuring classification accuracy

- **F1**: a weighted average of **precision** and **recall**

$$\mathrm{F1} = \frac{2 \cdot \mathrm{Precision} \cdot \mathrm{Recall}}{\mathrm{Precision} + \mathrm{Recall}}$$

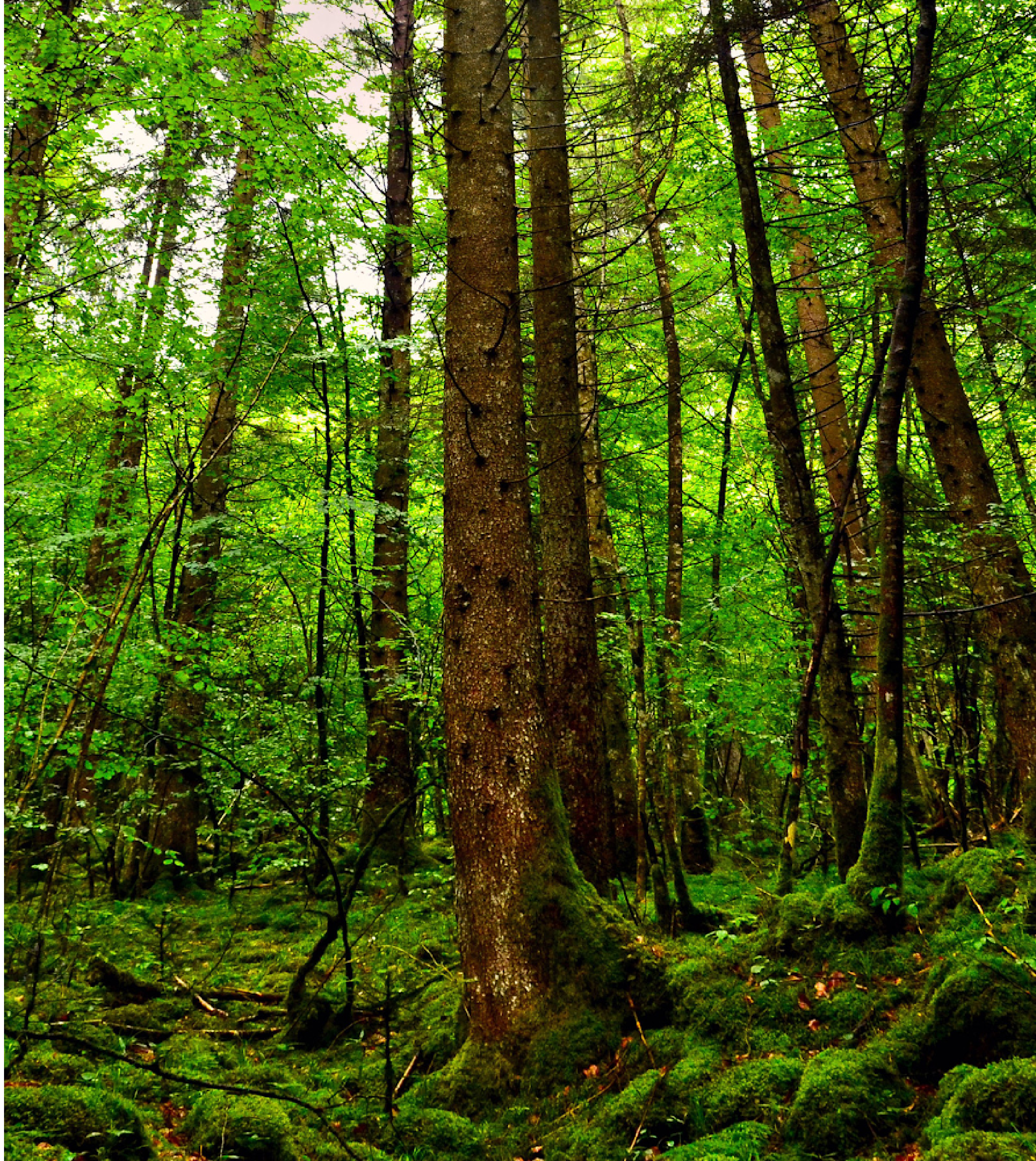
Ensembles in the wild

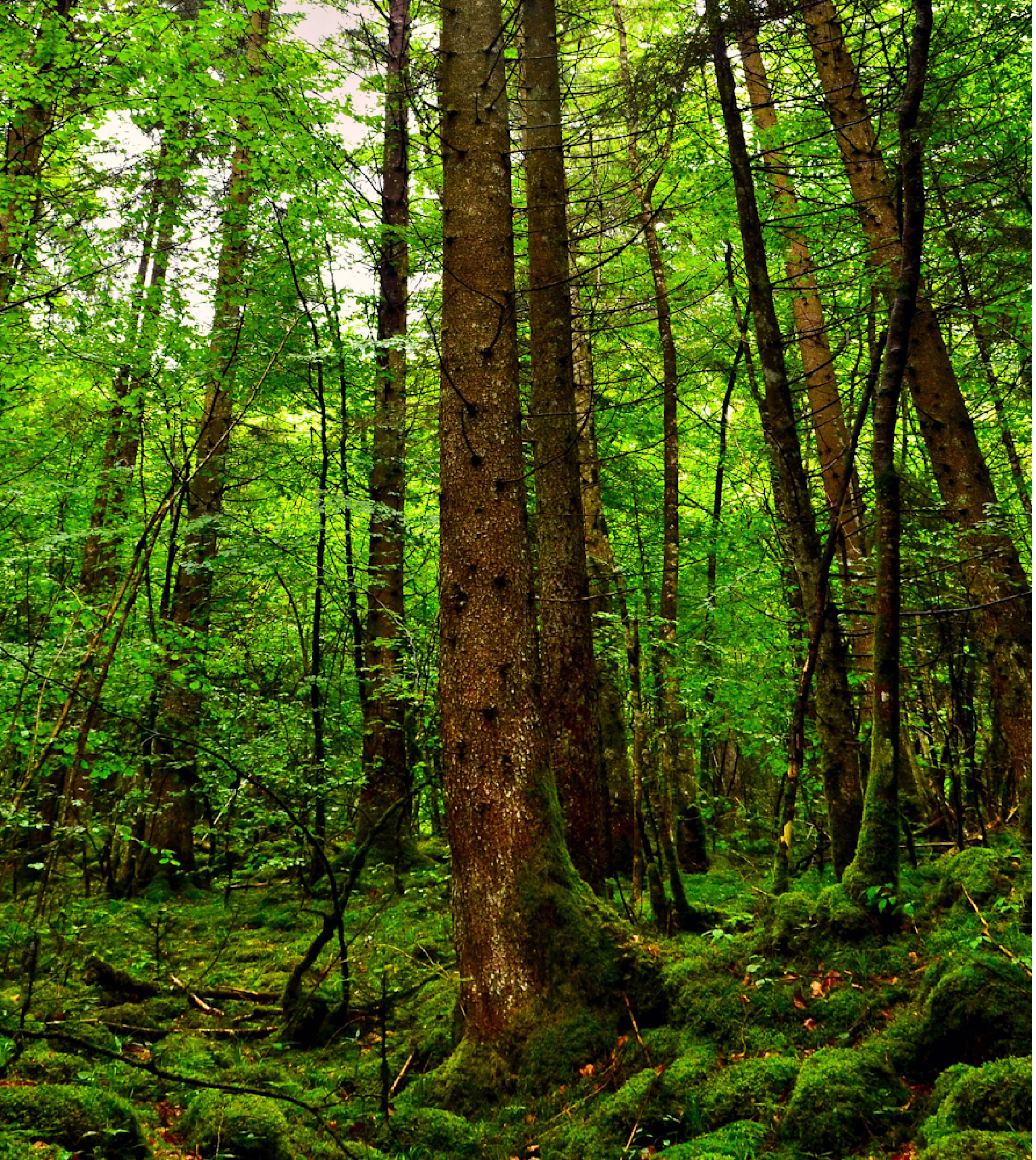
- People become ensembles when we vote
- Reduces the noise in important outcomes

Ensembles in the wild

- Winning against the line in sports betting is hard!
  - You have to beat an **ensemble**!
- Accuracy of Groups in Sports Betting

Ensemble models are computer democracy





Random forests

- A forest of decision trees
- Each tree is assigned a **random** set of **variables and data**
- Lots of unique trees
- The trees vote according to their predictions

Other ensembles

- **Bagging**
    - The concept behind random forests
    - Make lots of similar models, then aggregate predicitons
- **Boosting**
    - Iterative models
    - Train a model to focus on its weaknesses
    - Each round emphasizes the remaining mistakes

Other ensembles

- **Stacking**
  - Using models as inputs to other models
  - Build one or more SVMs or linear models (or any other kind of model!), and then feed the results into a new model

xgBoost

Just like Random Forests are extremely popular, **xgBoost** is a boosting model based on trees that is powerful, efficient, and popular in predictive modeling

For lab

- Together with your team, build an ensemble model. You can use Random Forests, another ensemble model, or even experiment by building your own!
- Try to get the best accuracy (or precision! or recall! or F1!) that you can!
- If you are lost, ASK QUESTIONS! You might also want to refer to the tutorial videos again.