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Te Whare Wānanga o Waikato

Data Mining with Weka

Class 2 – Lesson 1

Be a classifier!

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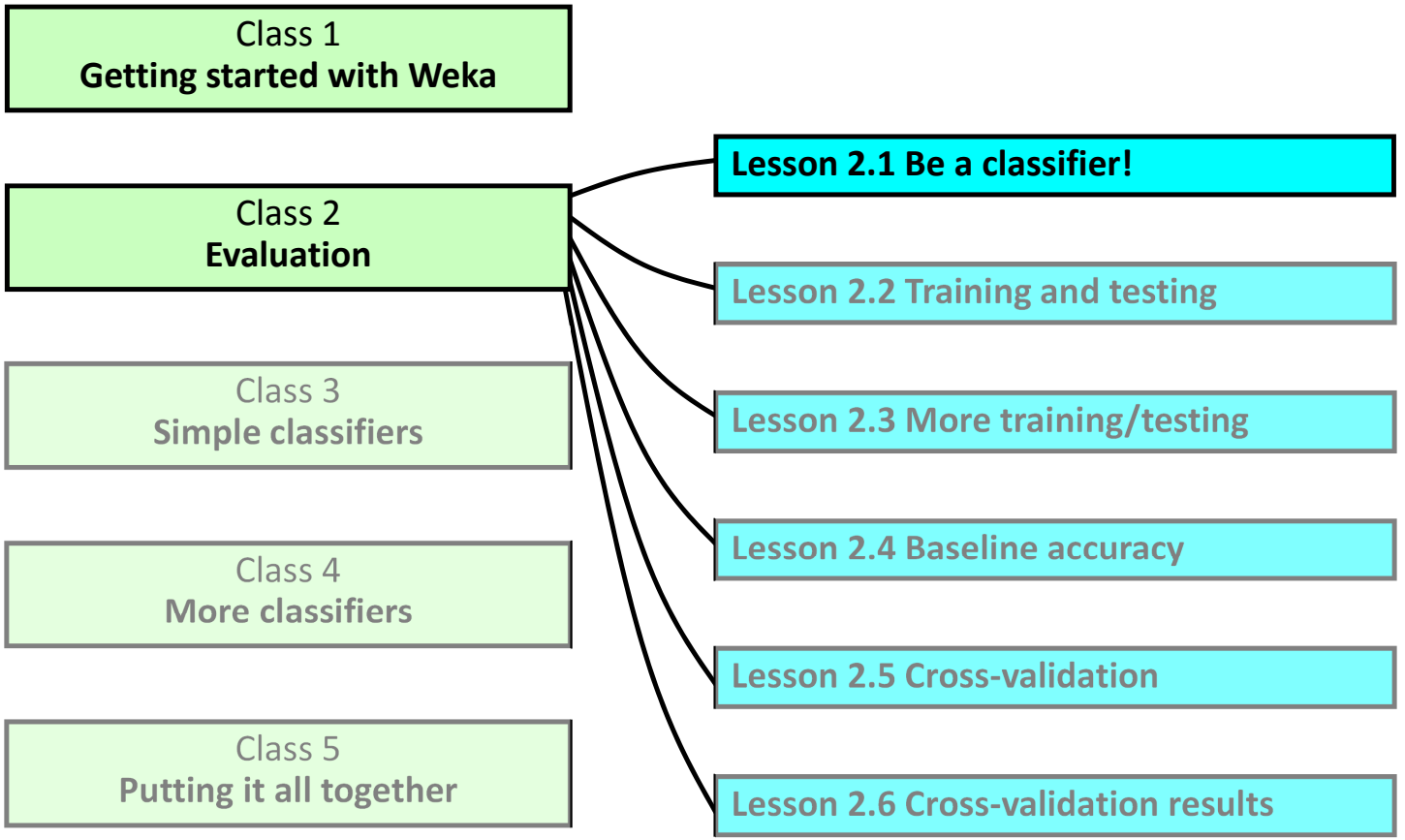
Lesson 2.1: Be a classifier!



Lesson 2.1: Be a classifier!

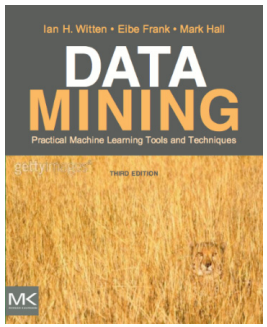
Interactive decision tree construction

- Load segmentchallenge.arff; look at dataset
- Select UserClassifier (tree classifier)
- Use the test set segmenttest.arff
- Examine data visualizer and tree visualizer
- Plot regioncentroidrow vs intensitymean
- Rectangle, Polygon and Polyline selection tools
- … several selections …
- Rightclick in Tree visualizer and Accept the tree

Over to you: how well can you do?

Lesson 2.1: Be a classifier!

- Build a tree: what strategy did you use?
- Given enough time, you could produce a "perfect" tree for the dataset
  - but would it perform well on the test data?



Course text

- Section 11.2 *Do it yourself: the User Classifier*

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Data Mining with Weka

Class 2 – Lesson 2

Training and testing

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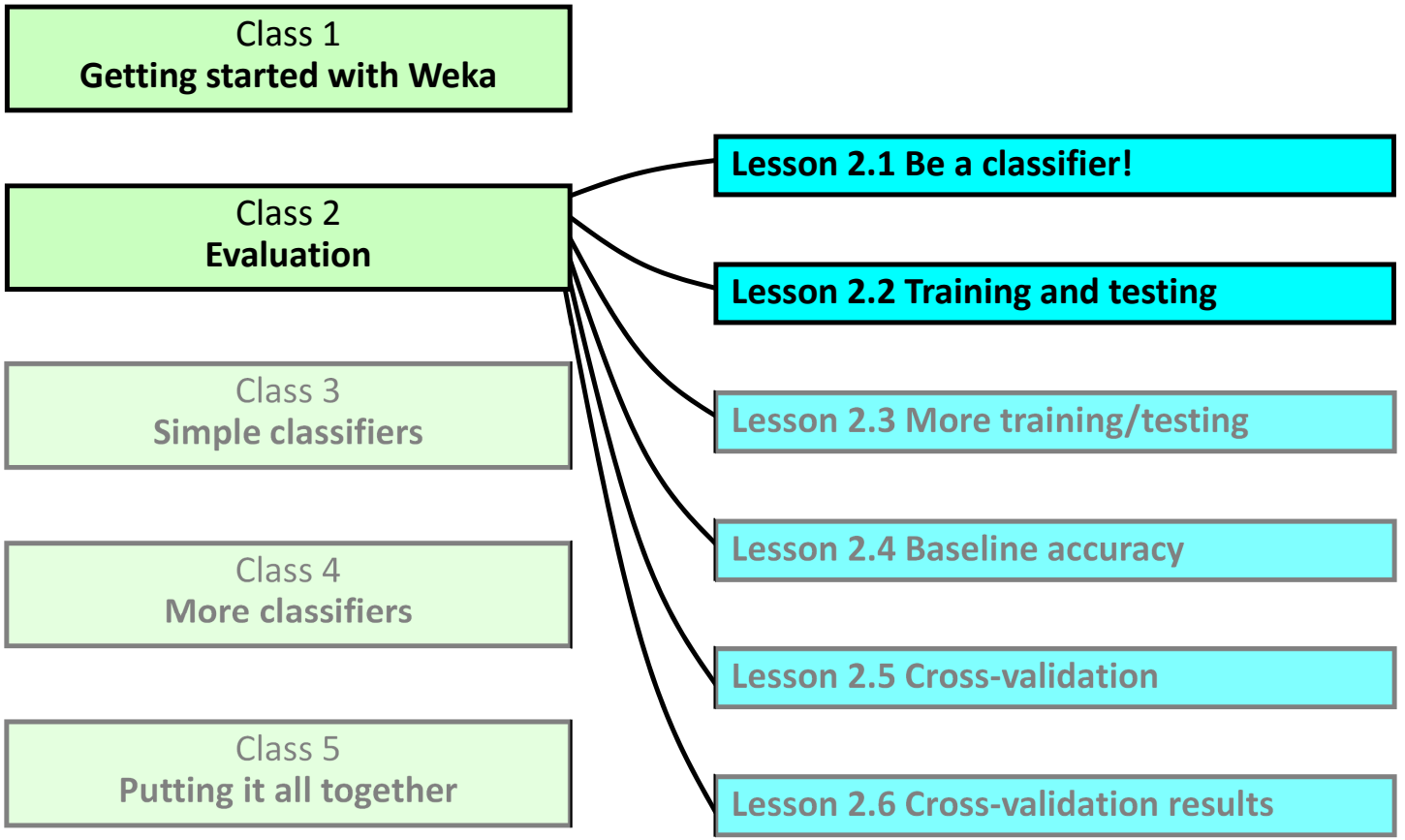
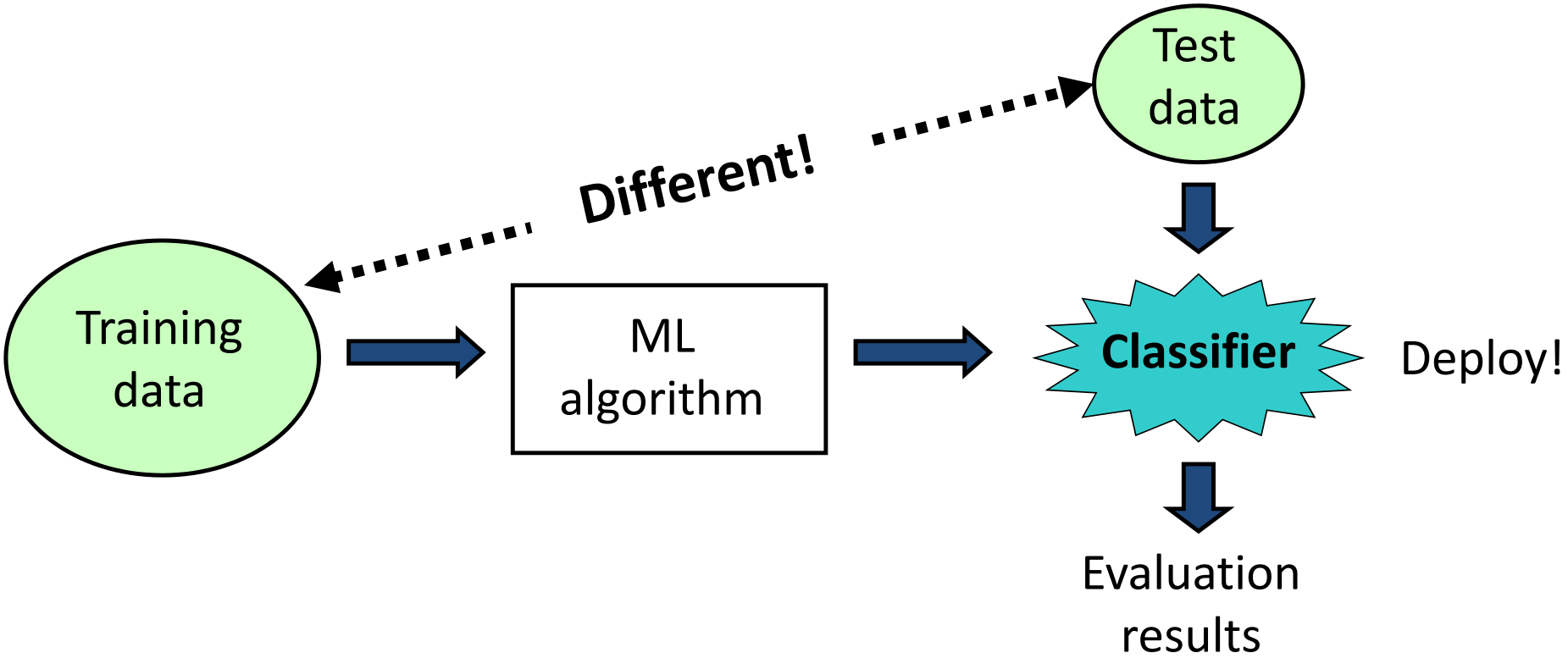
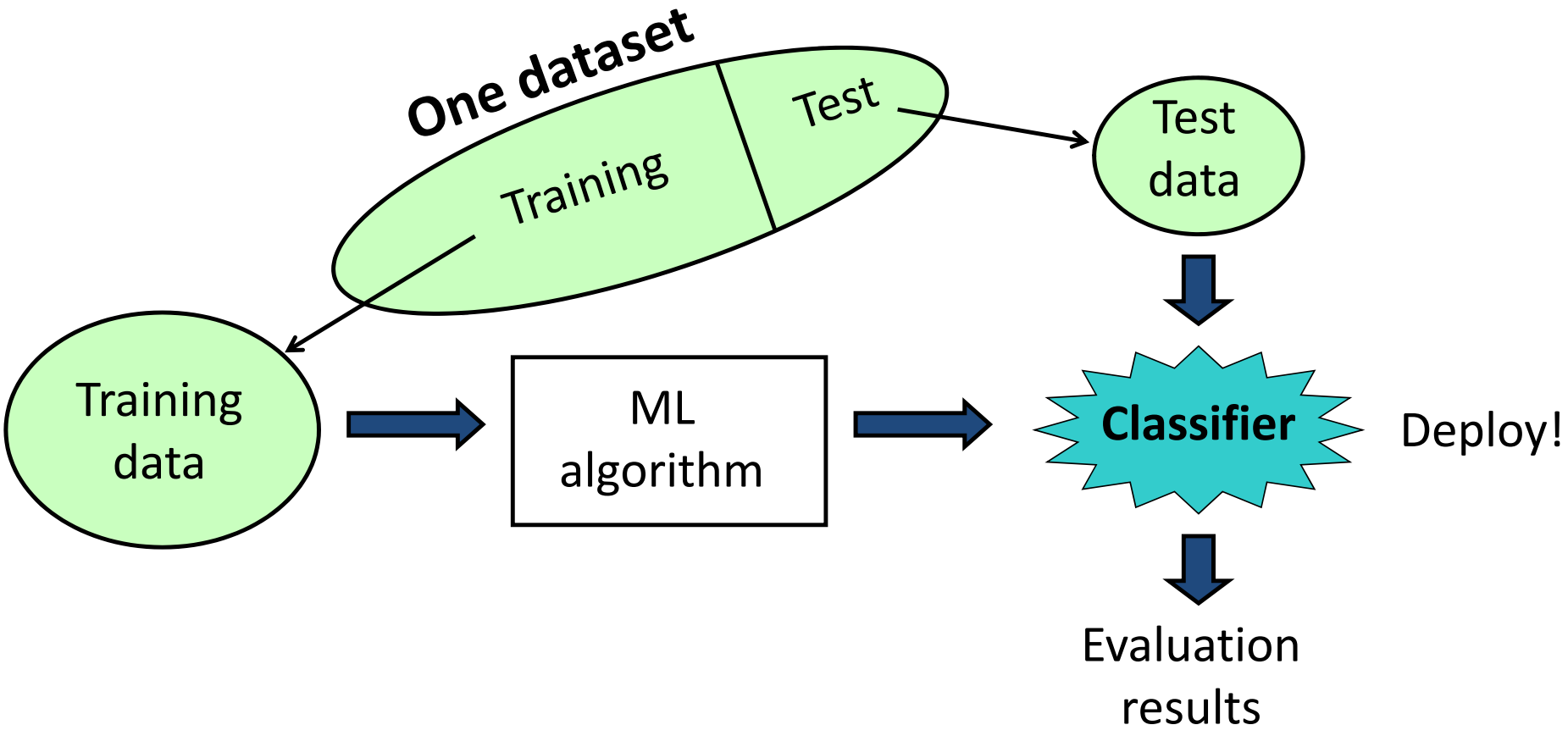
Lesson 2.2: Training and testing



Lesson 2.2: Training and testing



Lesson 2.2: Training and testing



Basic assumption: training and test sets produced by independent sampling from an infinite population

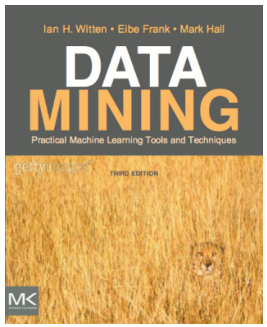
Lesson 2.2: Training and testing

Use J48 to analyze the segment dataset

- Open file segment-challenge.arff
- Choose J48 decision tree learner (trees>J48)
- Supplied test set segment-test.arff
- Run it: 96% accuracy
- Evaluate on training set: 99% accuracy
- Evaluate on percentage split: 95% accuracy
- Do it again: get exactly the same result!

Lesson 2.2: Training and testing

- Basic assumption:
  training and test sets sampled independently from an infinite population
- Just one dataset? — hold some out for testing
- Expect slight variation in results
- … but Weka produces same results each time
- J48 on segment-challenge dataset



Course text

- Section 5.1 *Training and testing*

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Data Mining with Weka

Class 2 – Lesson 3

Repeated training and testing

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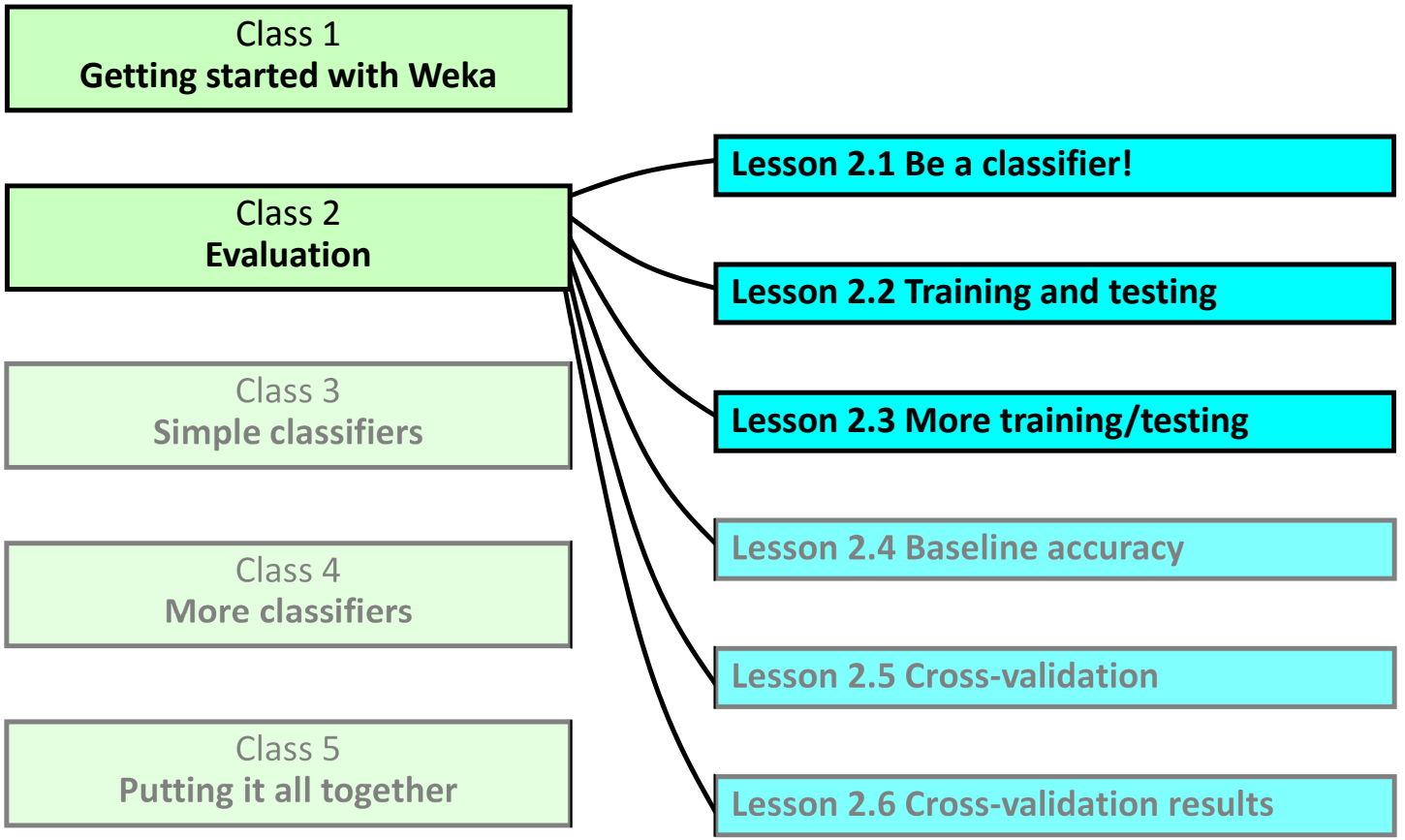
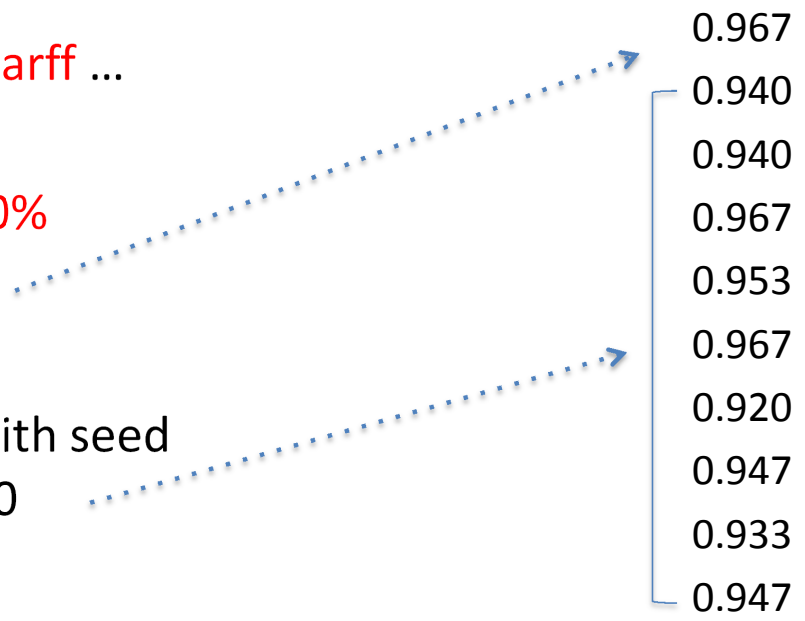
Lesson 2.3: Repeated training and testing



Lesson 2.3: Repeated training and testing

Evaluate J48 on segment-challenge

- With segment-challenge.arff …
- and J48 (trees>J48)
- Set percentage split to 90%
- Run it: 96.7% accuracy
- Repeat
- [More options] Repeat with seed
  2, 3, 4, 5, 6, 7, 8, 9 10



Lesson 2.3: Repeated training and testing

Evaluate J48 on segment-challenge

Sample mean $\overline{x} = \frac{\sum x_i}{n}$

Variance $\sigma^2 = \frac{\sum (x_i - \overline{x})^2}{n-1}$

Standard deviation σ

0.967
0.940
0.940
0.967
0.953
0.967
0.920
0.947
0.933
0.947

$\overline{x} = 0.949$, $\sigma = 0.018$

Lesson 2.3: Repeated training and testing

- Basic assumption:
  training and test sets sampled independently from an infinite population
- Expect slight variation in results …
- … get it by setting the random-number seed
- Can calculate mean and standard deviation experimentally

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Data Mining with Weka

Class 2 – Lesson 4

Baseline accuracy

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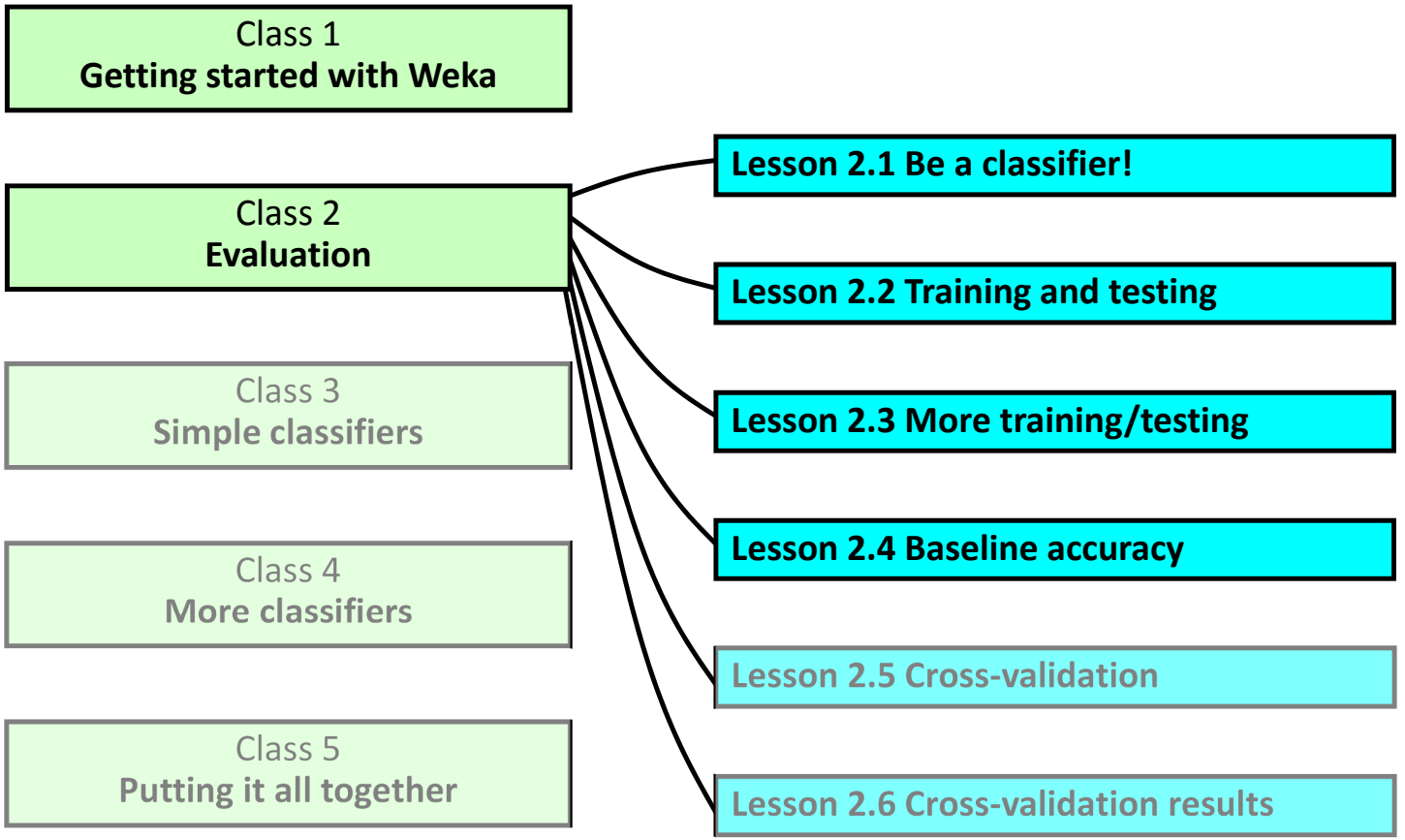
Lesson 2.4: Baseline accuracy



Lesson 2.4: Baseline accuracy

Use diabetes dataset and default holdout

- Open file **diabetes.arff**
- Test option: Percentage split
- Try these classifiers:
  - ***trees > J48*** **76%**
  - ***bayes > NaiveBayes*** **77%**
  - ***lazy > IBk*** **73%**
  - ***rules > PART*** **74%**

  (we'll learn about them later)
- 768 instances (500 negative, 268 positive)
- Always guess "negative": 500/768 **65%**
- **rules > ZeroR**: most likely class!

Lesson 2.4: Baseline accuracy

Sometimes baseline is best!

- Open **supermarket.arff** and blindly apply

rules > ZeroR	**64%**
trees > J48	**63%**
bayes > NaiveBayes	**63%**
lazy > IBk	**38% (!!)**
rules > PART	**63%**

- Attributes are not informative
- Don't just apply Weka to a dataset:
  you need to understand what's going on!

Lesson 2.4: Baseline accuracy

- Consider whether differences are likely to be significant
- Always try a simple baseline,
  e.g. rules > ZeroR

- Look at the dataset
- Don't blindly apply Weka:
  try to understand what's going on!

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Data Mining with Weka

Class 2 – Lesson 5

Cross-validation

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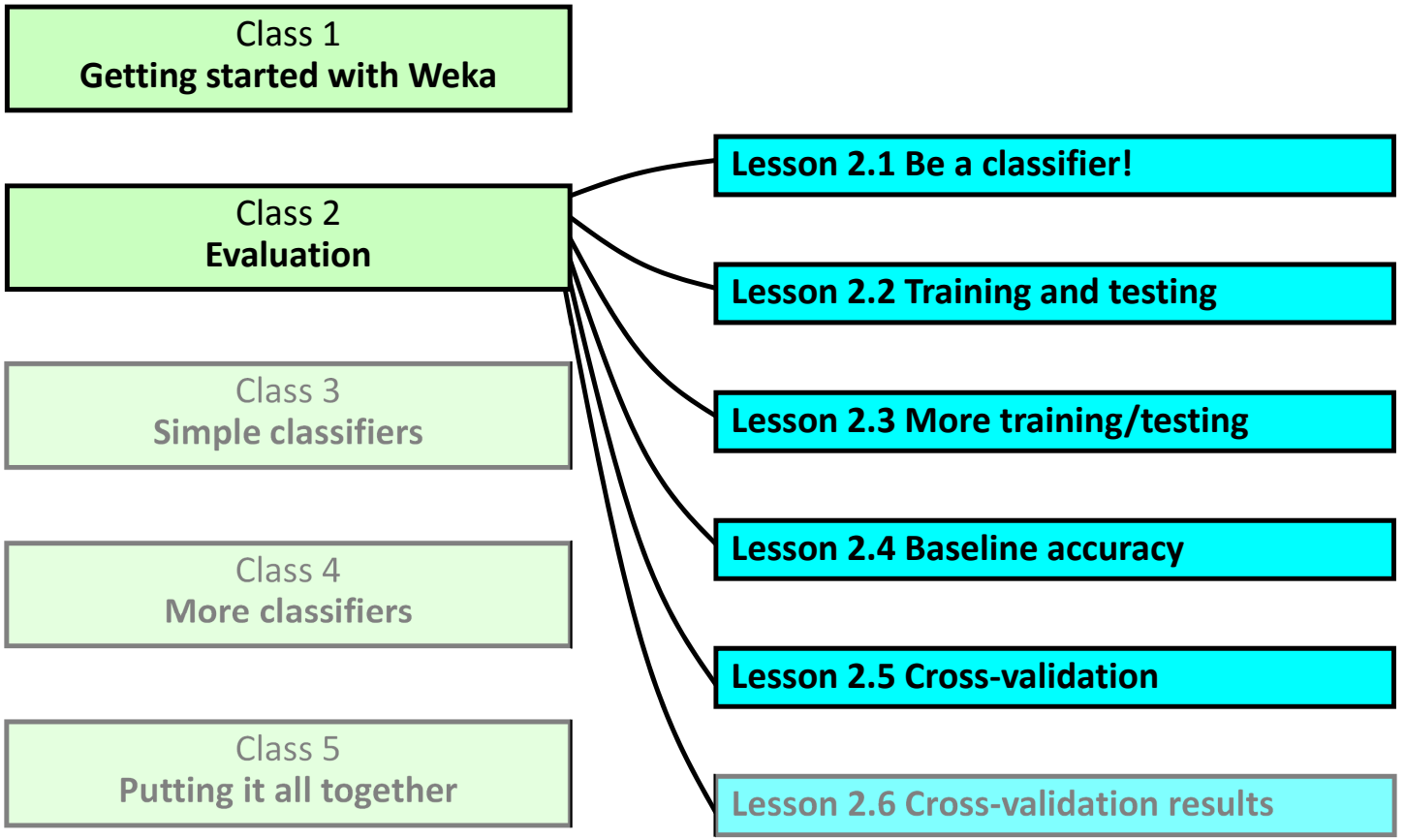
Lesson 2.5: Cross-validation

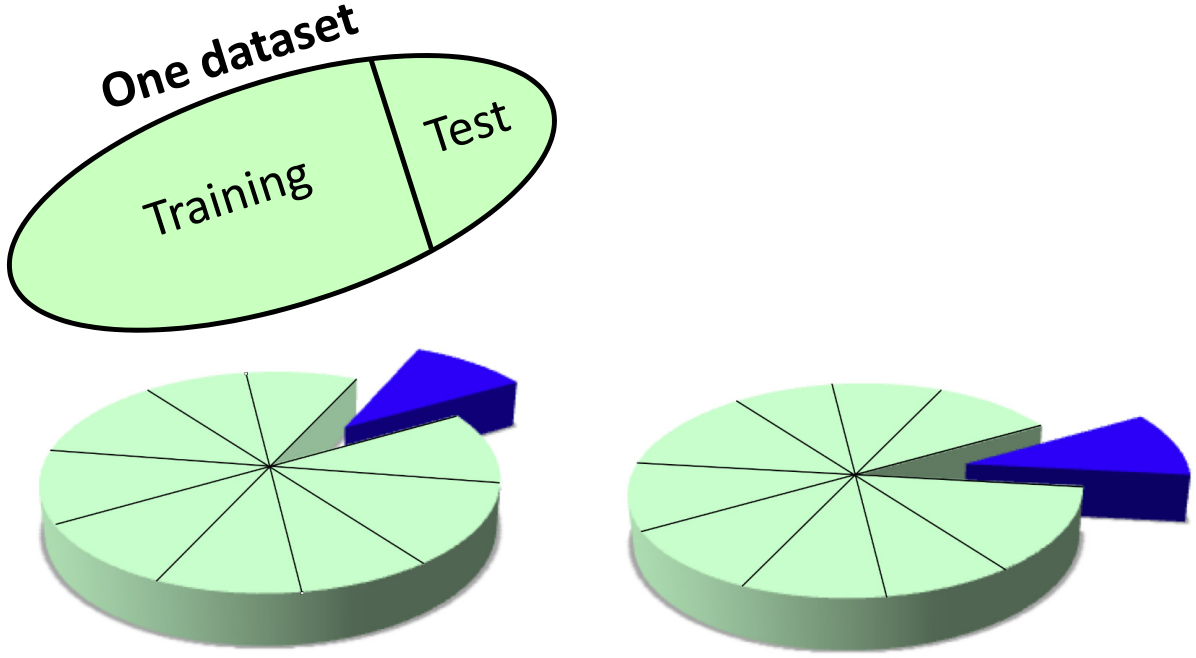


Lesson 2.5: Cross-validation

- Can we improve upon repeated holdout?
  (i.e. reduce variance)
- Cross-validation
- Stratified cross-validation

Lesson 2.5: Cross-validation

- Repeated holdout
  (in Lesson 2.3, hold out 10% for testing, repeat 10 times)

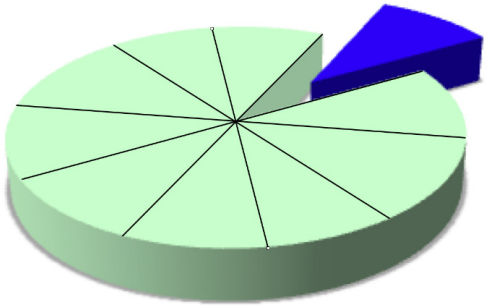


(repeat 10 times)

Lesson 2.5: Cross-validation

10-fold cross-validation

- Divide dataset into 10 parts (folds)
- Hold out each part in turn
- Average the results
- Each data point used once for testing, 9 times for training

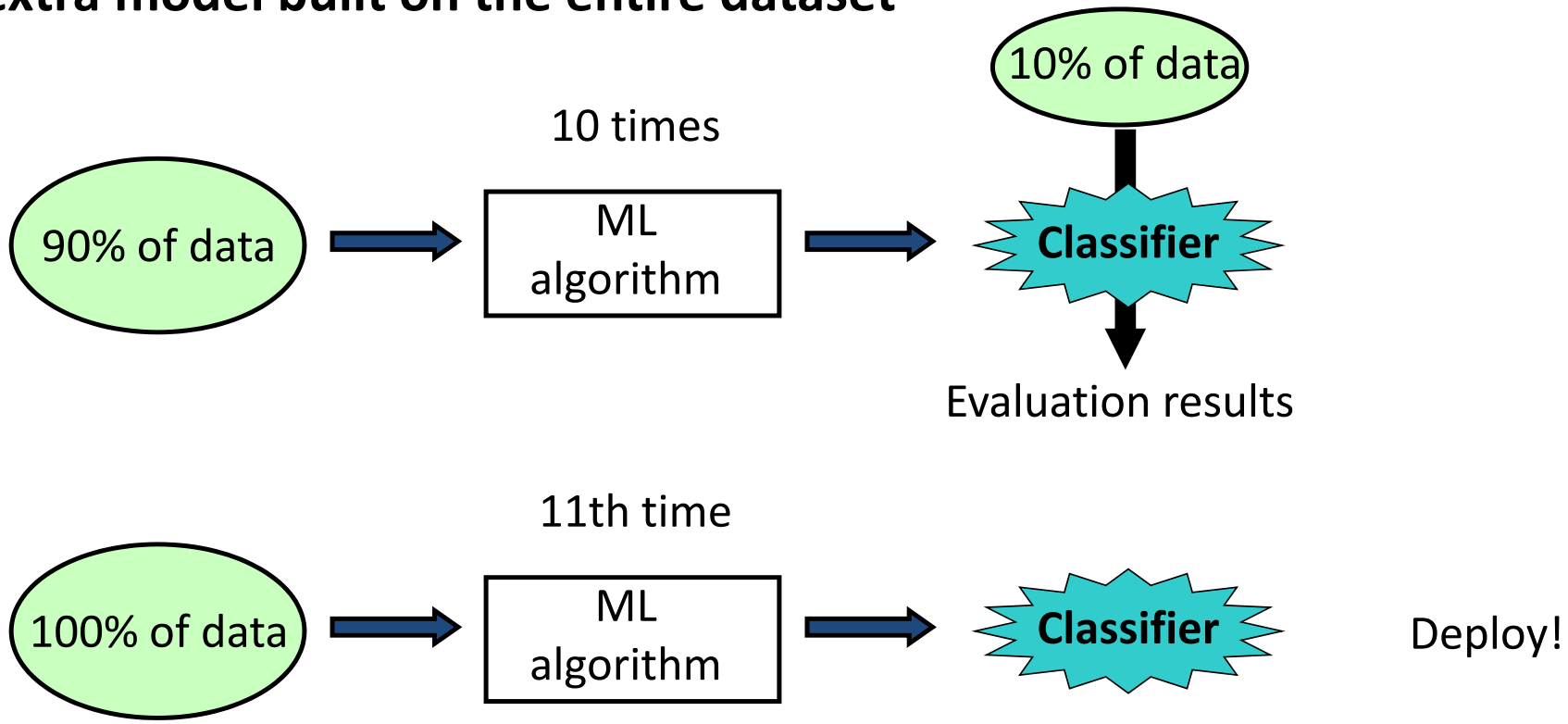


Stratified cross-validation

- Ensure that each fold has the right proportion of each class value

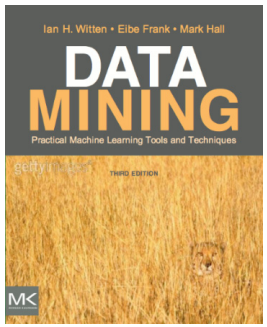
Lesson 2.5: Cross-validation

After cross-validation, Weka outputs an extra model built on the entire dataset



Lesson 2.5: Cross-validation

- Cross-validation better than repeated holdout
- Stratified is even better
- With 10-fold cross-validation, Weka invokes the learning algorithm 11 times
- **Practical rule of thumb:**
- Lots of data? – use percentage split
- Else stratified 10-fold cross-validation



Course text

- Section 5.3 *Cross-validation*

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Data Mining with Weka

Class 2 – Lesson 6

Cross-validation results

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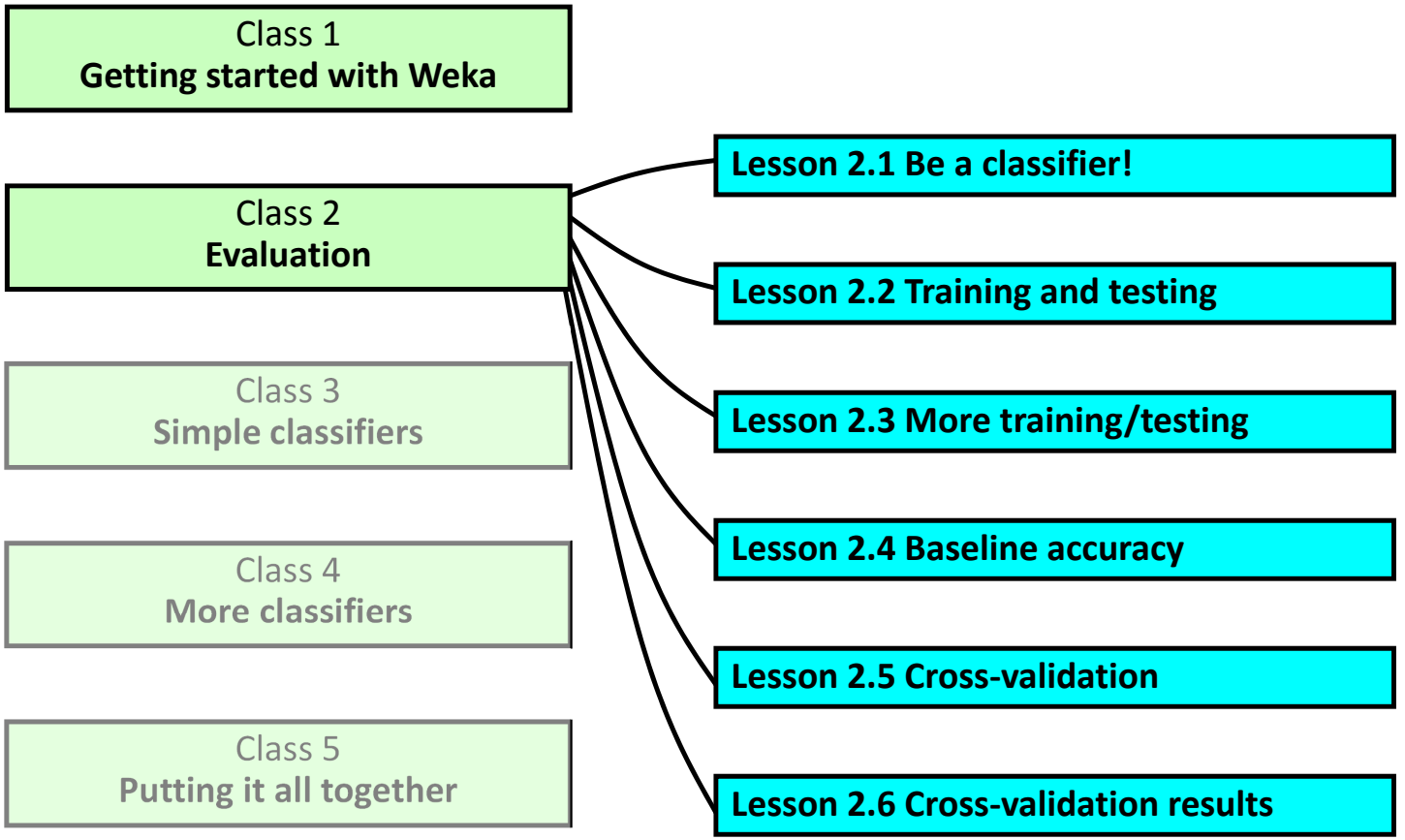
Lesson 2.6: Cross-validation results



Lesson 2.6: Cross-validation results

Is cross-validation really better than repeated holdout?

- **Diabetes** dataset
- Baseline accuracy (**rules > ZeroR**): 65.1%
- **trees > J48**
- 10-fold cross-validation 73.8%
- … with different random number seed

1	2	3	4	5	6	7	8	9	10
73.8	75.0	75.5	75.5	74.4	75.6	73.6	74.0	74.5	73.0

Lesson 2.6: Cross-validation results

Sample mean $\bar{x} = \frac{\sum x_i}{n}$

Variance $\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{n-1}$

Standard deviation σ

holdout (10%)	cross-validation (10-fold)
75.3	73.8
77.9	75.0
80.5	75.5
74.0	75.5
71.4	74.4
70.1	75.6
79.2	73.6
71.4	74.0
80.5	74.5
67.5	73.0
$\bar{x} = 74.8$	$\bar{x} = 74.5$
$\sigma = 4.6$	$\sigma = 0.9$

Lesson 2.6: Cross-validation results

- Why 10-fold? E.g. 20-fold: 75.1%

- Cross-validation really is better than repeated holdout
- It reduces the variance of the estimate

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