Q: What is a classifier?

iClicker

A. *This option is intentionally left blank*

B. A method to predict the future

C. An algorithm that maps input data to a specific category

D. A type of decision tree used for data mining

E. A type of data storage for algorithms

CPSC 100

Computational Thinking

Algorithm, Classifiers and Trees!

Instructor: Parsa Rajabi
Department of Computer Science
University of British Columbia

Agenda

- Course Admin
- Recap
  - Classifiers
  - Decision Trees
- Entropy

Learning Goals

Learning Goals

After this lecture, you should be able to:

- Describe the **classification** steps.
- Explain the concept of a **rooted tree** and **decision tree**.
- Describe what the general decisions are in building a decision tree.
    - **Build a decision tree using entropy.**
- Describe **what considerations** are important in building a decision tree.

Course Admin

Course Admin

- **Lab #2**
  - Due on Friday, Jan 24 at 11:59pm
- **Post-Class (PC) Quiz #1**
  - Only 1 attempt, 60 minutes
  - Open book, open-AI* (*you must disclosure your usage)
  - Due on Sunday, Jan 26 at 11:59pm
- **Group Contracts**
  - Extended to Monday, Jan 27 at 11:59pm
- **PC Quiz #2**
  - To be released next week!

Algorithms

Recall

Algorithms

An ***algorithm*** describes a sequence of steps that is:

1. Unambiguous
   - No “assumptions” are required to execute the algorithm
   - The algorithm uses precise instructions
2. Executable
   - The algorithm can be carried out in practice
3. Terminating
   - The algorithm will eventually come to an end, or halt

Recall

Classifiers

Classifier

Recall

- A **classifier** is an **algorithm** that maps the input data to a specific category
  - Classifiers are derived from patterns or correlations from data.

Classifier: Training vs Test Data

Recall

- The data that classifiers learn the patterns has the "answer"
  - This data is called **training data**.

- Some of the training data is held back to check and see if the classifier works.
  - This is called **test data.**

Classifiers + Data

Recall

Classifiers then apply these patterns to new data with no “answer”

- **Input:** Digital image
- **Output:** Cat/not a cat
- **Training data:**
  Labeled images of cats and images that are not cats

Recall

Classification Task - Loan Applications

Input: Individual's loan application

- Address, age, gender, credit rating, etc.

Output: Acceptance/Rejection

Training data:

List of loan apps, decisions made, and for those who were approved, whether they repaid the loan or not

Recall

Regular Trees

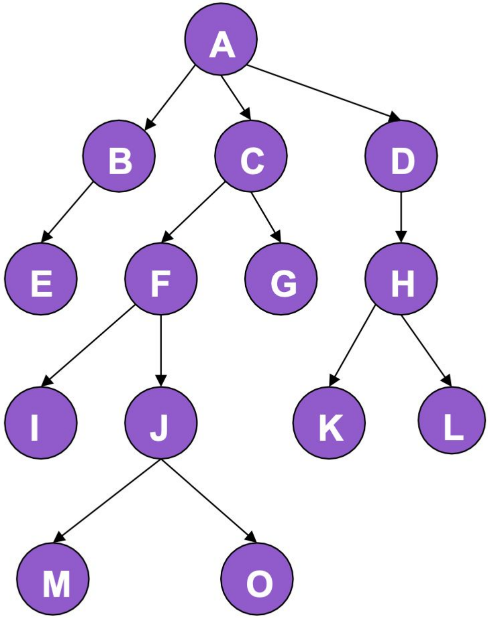
Recall

Trees in Computer Science

- A Decision Tree is a way for a computer to make decisions based on a series of questions.

A **tree** is a **collection of nodes** such that

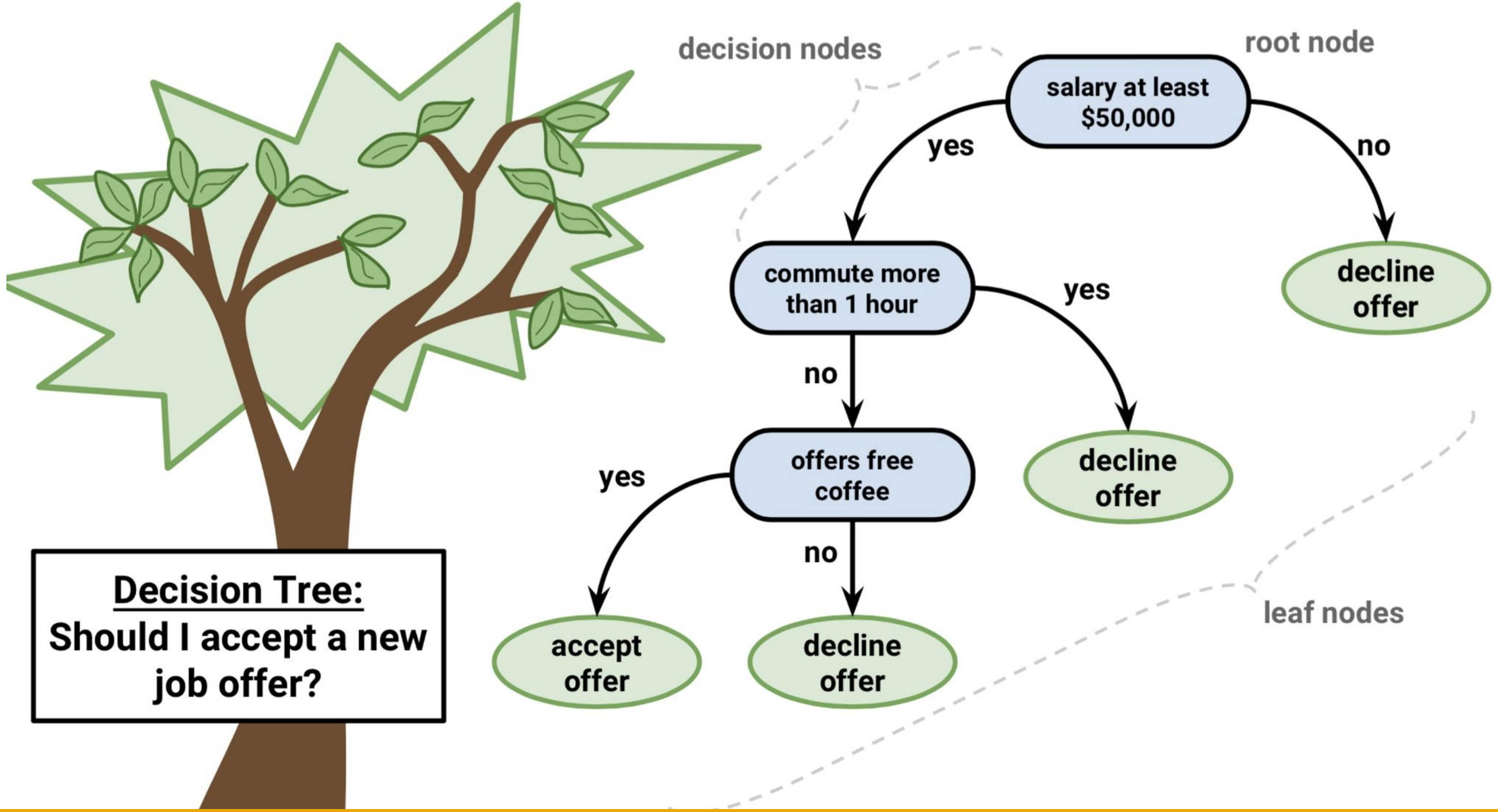
- One node is the designated ***root***.
- A node can have zero or more *children*;
- a node with zero children is a *leaf*.
- All non-root nodes have a single *parent*.
- *Edges* denote parent-child relationships.
- Nodes and/or edges may be labeled by data.
  - Each node on this tree is labeled by a letter



Recall

Decision trees

Trees whose node labels are attributes, edge labels are conditions



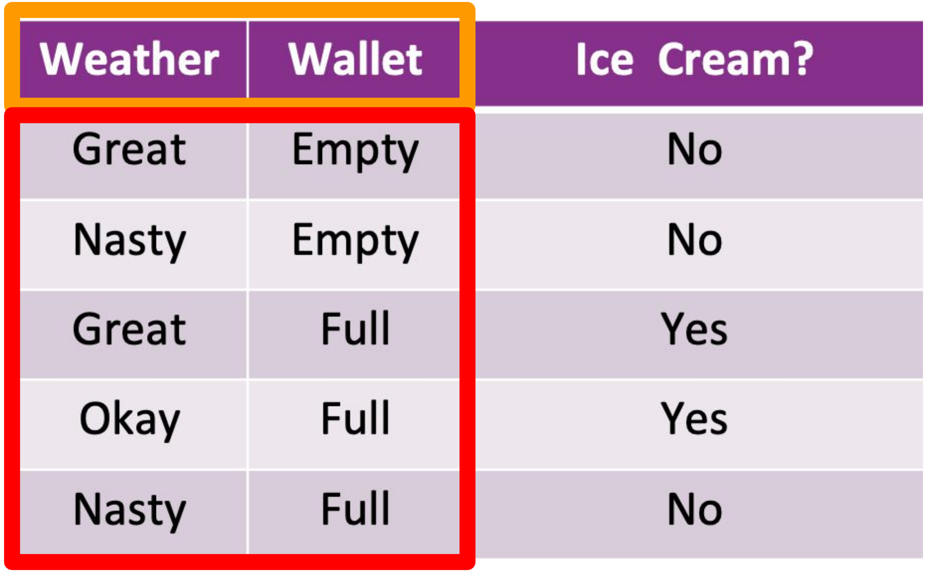
Recall

Building Decision Trees

- Should you get an ice cream?
- You might start out with the following data

Attributes

Conditions

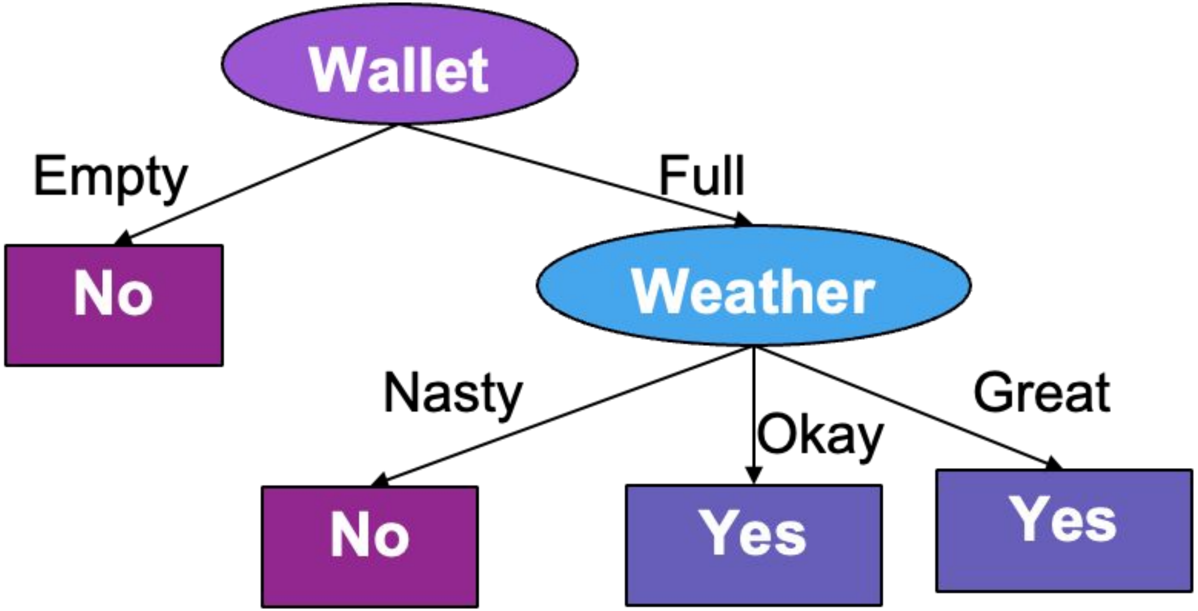


Weather	Wallet	Ice Cream?
Great	Empty	No
Nasty	Empty	No
Great	Full	Yes
Okay	Full	Yes
Nasty	Full	No

Recall

Should you get an ice cream?

Weather	Wallet	Ice Cream?
Great	Empty	No
Nasty	Empty	No
Great	Full	Yes
Okay	Full	Yes
Nasty	Full	No



Q: In classification, how is the accuracy of a classifier evaluated?

iClicker

A. By comparing training data with random data

B. By matching the classifier’s results with decisions from test data

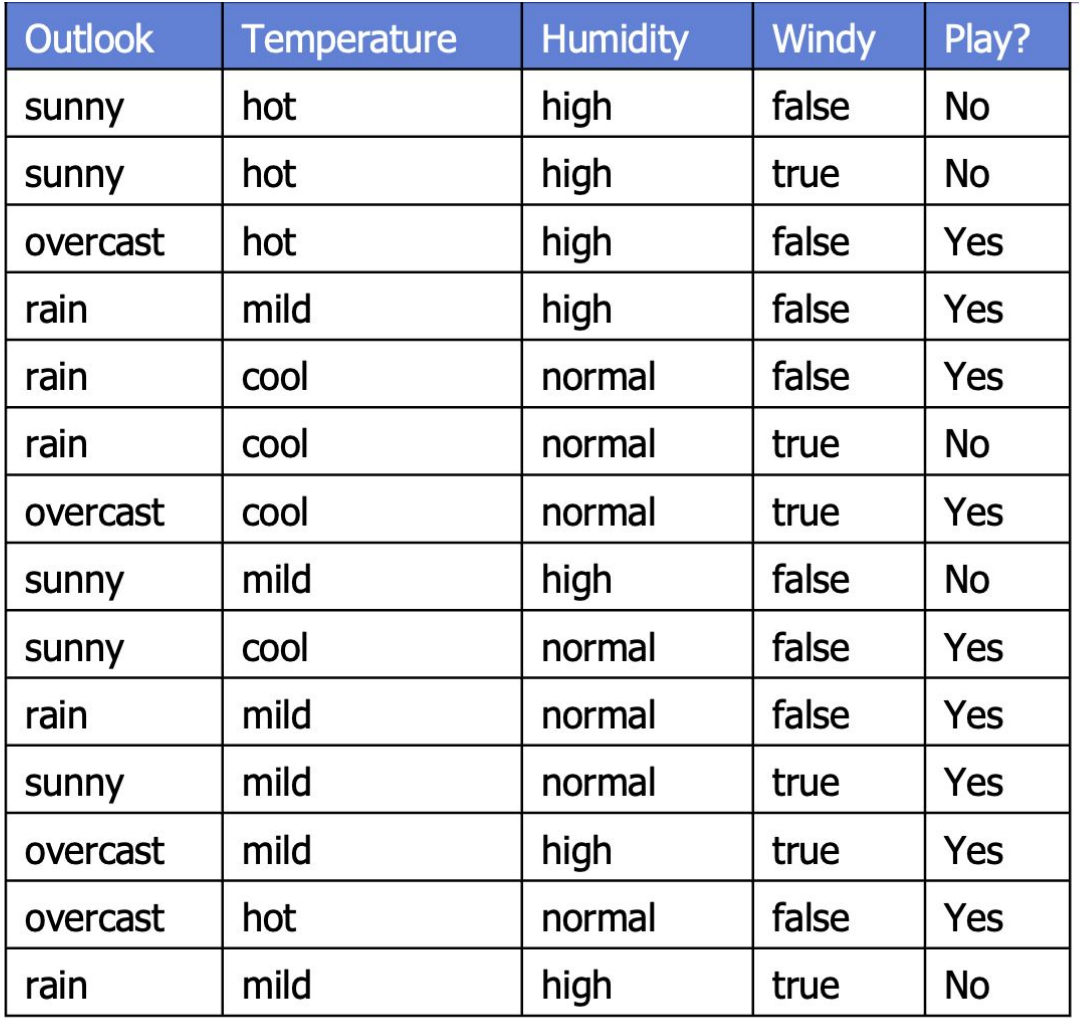
C. By ensuring the classifier can handle large datasets

D. By improving the efficiency of the algorithm

Soccer League:

Do we cancel the game?

Soccer League Data



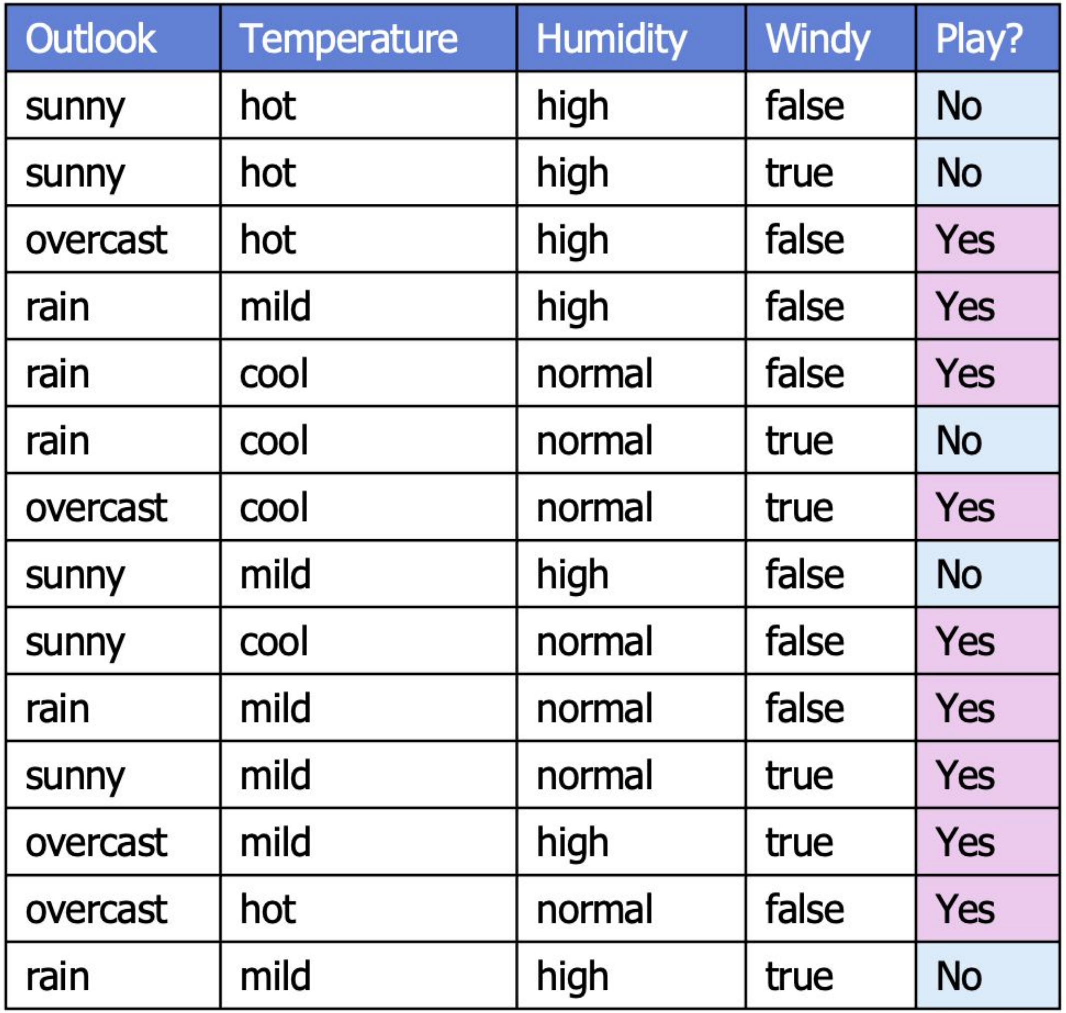
Outlook	Temperature	Humidity	Windy	Play?
sunny	hot	high	false	No
sunny	hot	high	true	No
overcast	hot	high	false	Yes
rain	mild	high	false	Yes
rain	cool	normal	false	Yes
rain	cool	normal	true	No
overcast	cool	normal	true	Yes
sunny	mild	high	false	No
sunny	cool	normal	false	Yes
rain	mild	normal	false	Yes
sunny	mild	normal	true	Yes
overcast	mild	high	true	Yes
overcast	hot	normal	false	Yes
rain	mild	high	true	No

Soccer League: Cancel Game?

- Build a **decision tree** to help officials decide
- Assume that decisions are the same given the same information
- The *leaf nodes* should be whether or not to play
- The *non-leaf* nodes should be **attributes** (e.g., Outlook, Windy)
- The edges should be **conditions** (e.g., sunny, hot, normal)

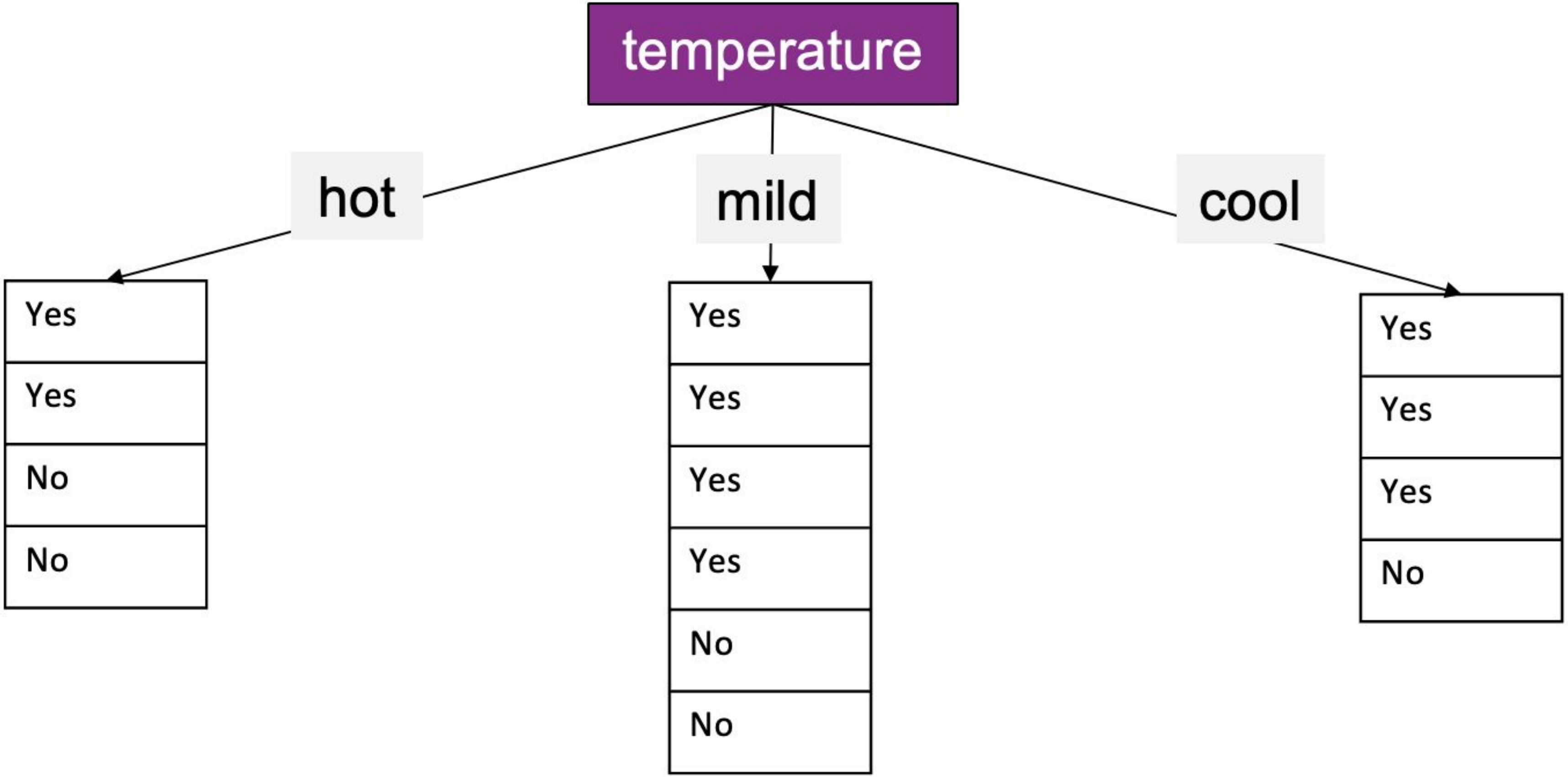
Want to have as few mixed “Yes” and “No” answers together in groups as possible.

At the start we have 14 mixed Yes’s/No’s



Outlook	Temperature	Humidity	Windy	Play?
sunny	hot	high	false	No
sunny	hot	high	true	No
overcast	hot	high	false	Yes
rain	mild	high	false	Yes
rain	cool	normal	false	Yes
rain	cool	normal	true	No
overcast	cool	normal	true	Yes
sunny	mild	high	false	No
sunny	cool	normal	false	Yes
rain	mild	normal	false	Yes
sunny	mild	normal	true	Yes
overcast	mild	high	true	Yes
overcast	hot	normal	false	Yes
rain	mild	high	true	No

What happens if we split data on **Temperature**?



temperature

hot

Yes

Yes

No

No

mild

Yes

Yes

Yes

Yes

No

No

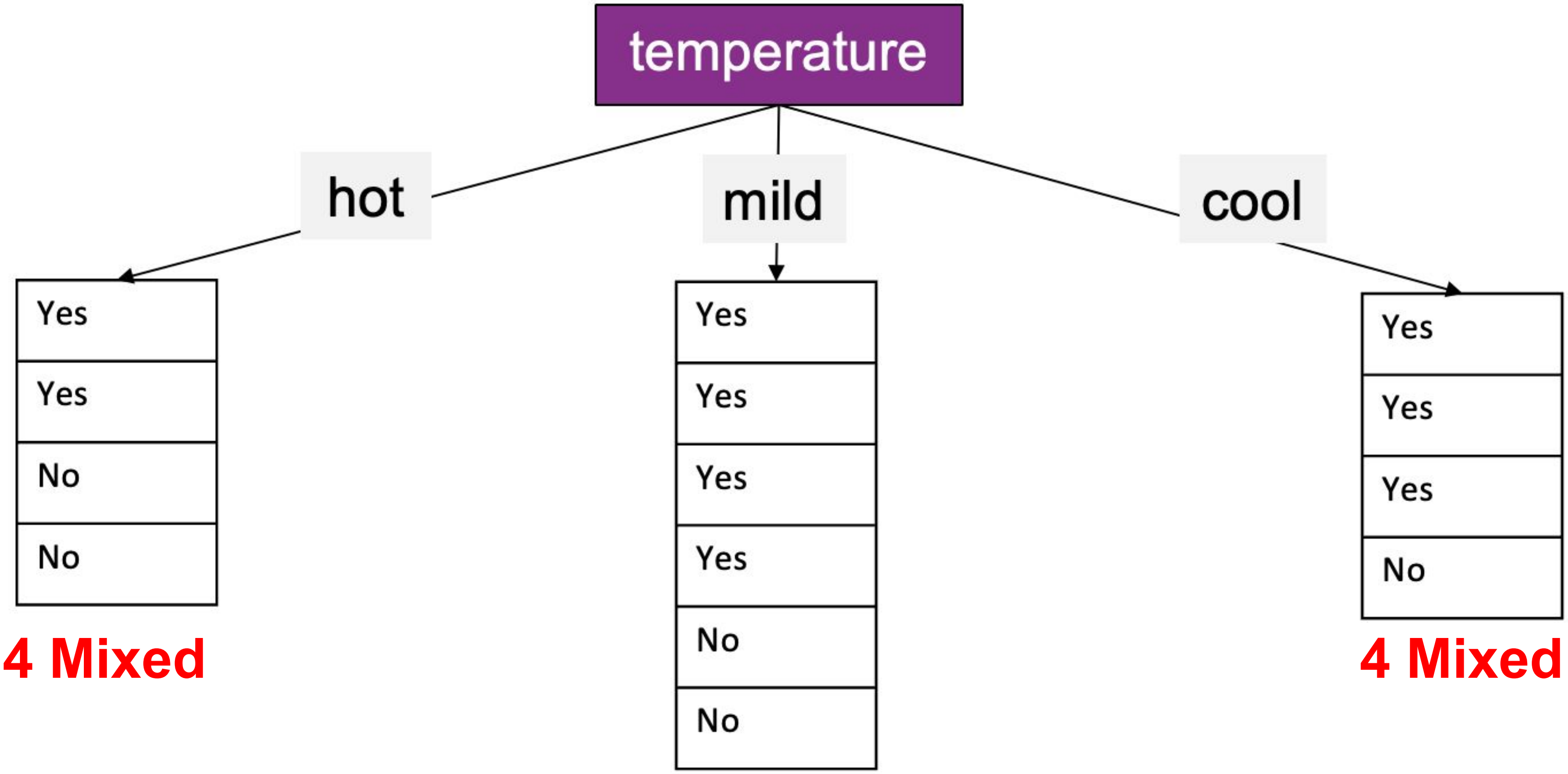
cool

Yes

Yes

Yes

No



temperature

hot

Yes
Yes
No
No

4 Mixed

mild

Yes
Yes
Yes
Yes
No
No

6 Mixed

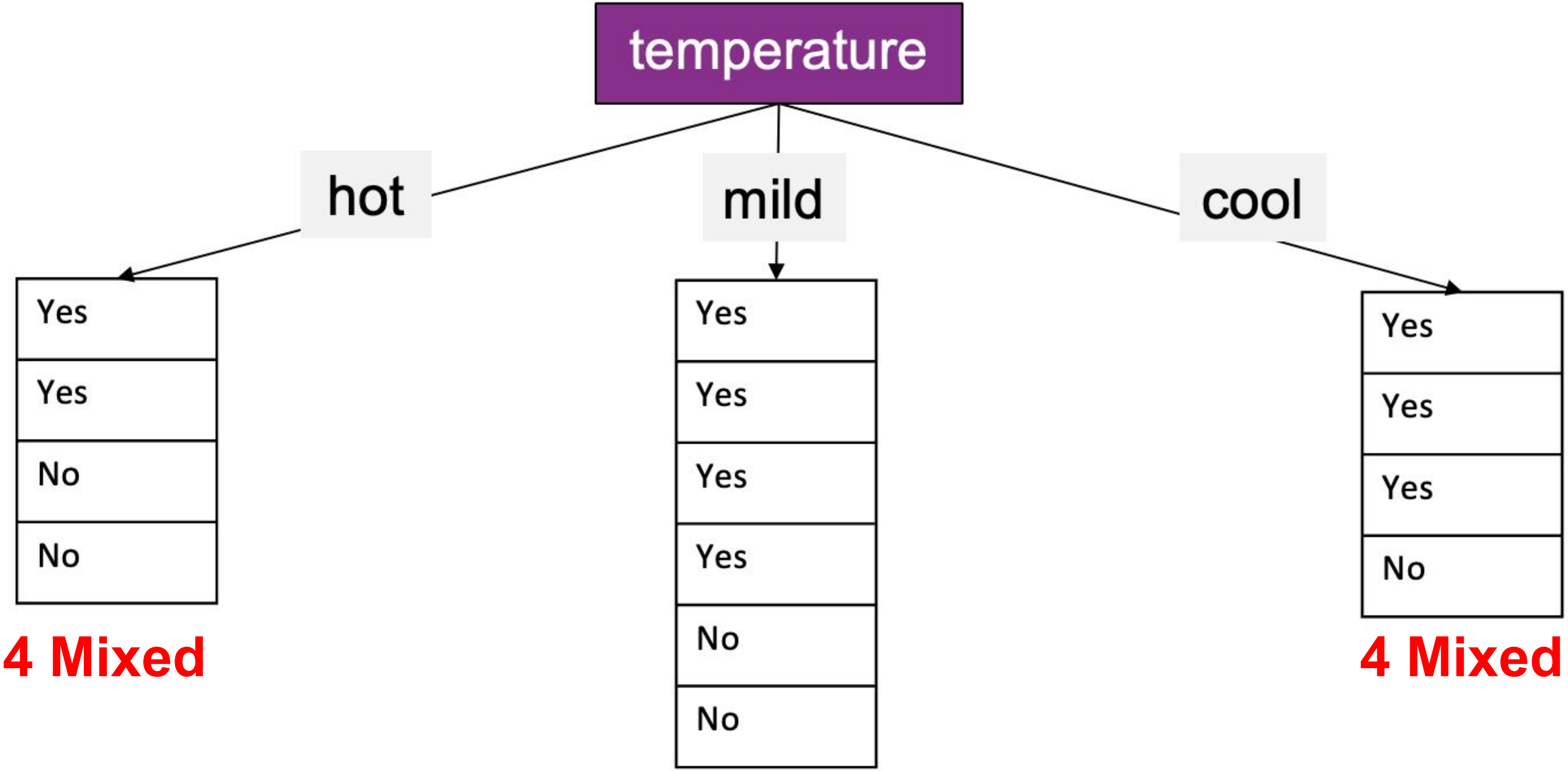
cool

Yes
Yes
Yes
No

4 Mixed

What is the **uncertainty (entropy)** in our data?

Overall entropy = 4 + 4 + 6 = 14



temperature

hot

Yes

Yes

No

No

4 Mixed

mild

Yes

Yes

Yes

Yes

No

No

6 Mixed

cool

Yes

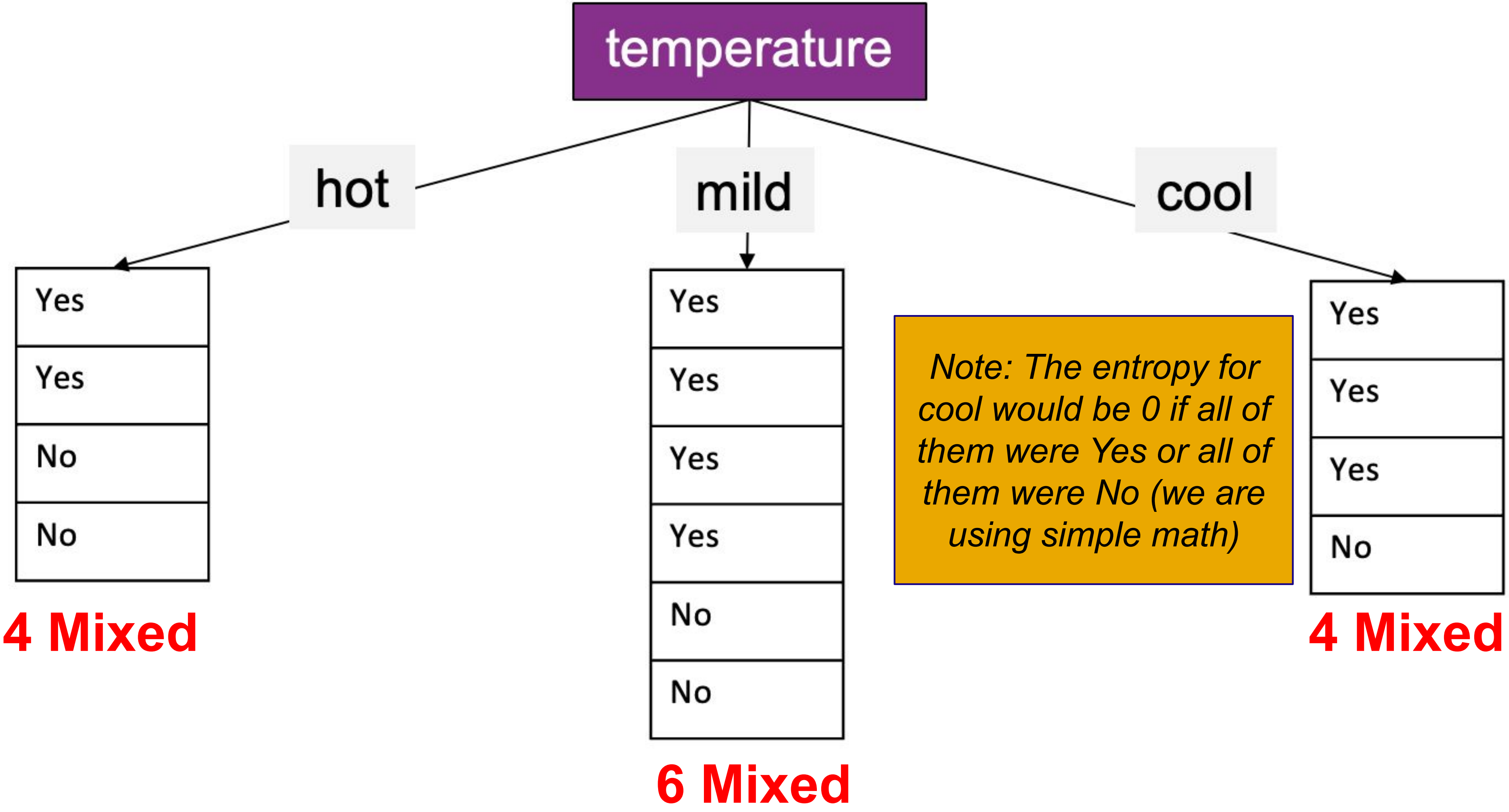
Yes

Yes

No

4 Mixed

Overall entropy = 4 + 4 + 6 = 14



temperature

hot

Yes
Yes
No
No

4 Mixed

mild

Yes
Yes
Yes
Yes
No
No

6 Mixed

cool

Yes
Yes
Yes
No

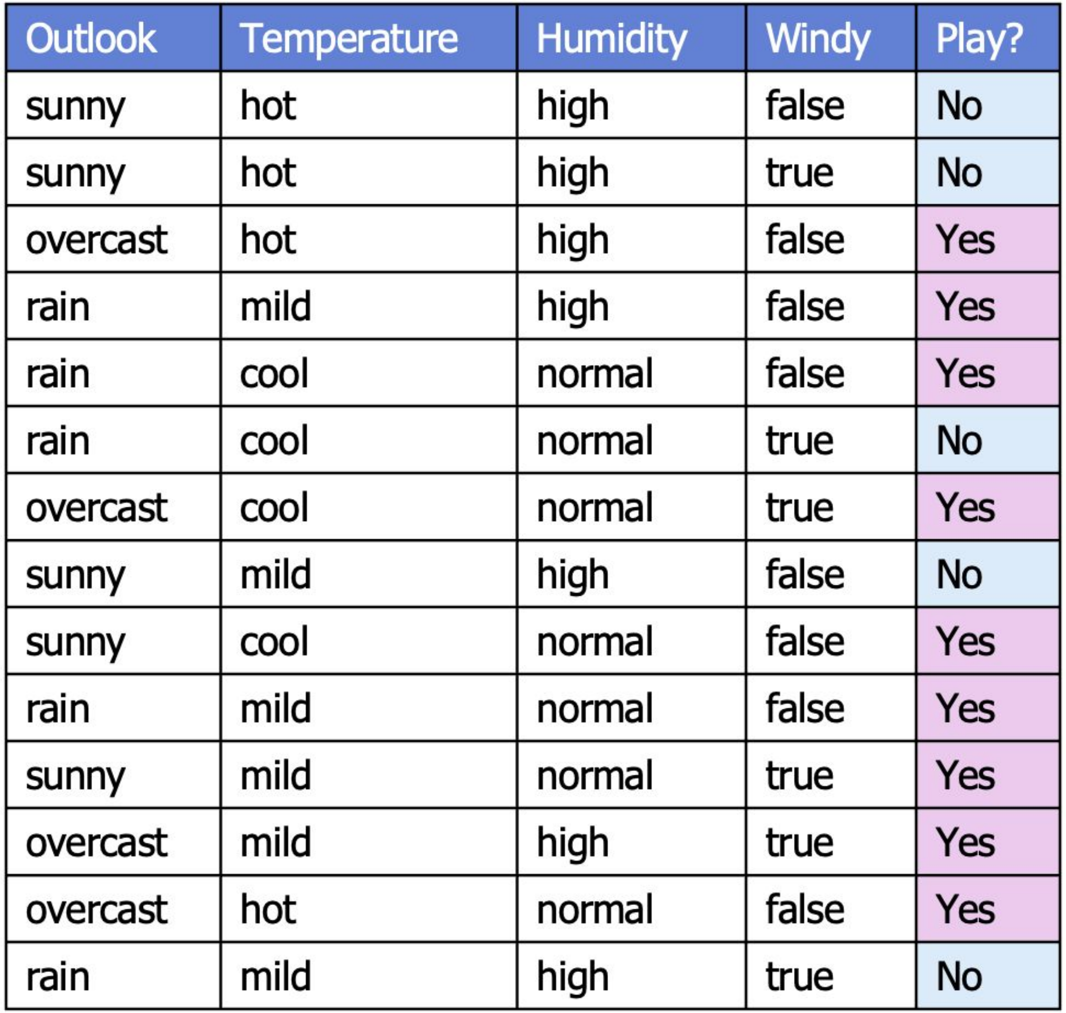
4 Mixed

Note: The entropy for cool would be 0 if all of them were Yes or all of them were No (we are using simple math)

In-class Activity

[Groups of 2-3]

What’s the entropy if you split on Outlook?



Outlook	Temperature	Humidity	Windy	Play?
sunny	hot	high	false	No
sunny	hot	high	true	No
overcast	hot	high	false	Yes
rain	mild	high	false	Yes
rain	cool	normal	false	Yes
rain	cool	normal	true	No
overcast	cool	normal	true	Yes
sunny	mild	high	false	No
sunny	cool	normal	false	Yes
rain	mild	normal	false	Yes
sunny	mild	normal	true	Yes
overcast	mild	high	true	Yes
overcast	hot	normal	false	Yes
rain	mild	high	true	No

Q: What’s the entropy if you split on Outlook?

iClicker

A. 0

B. 5

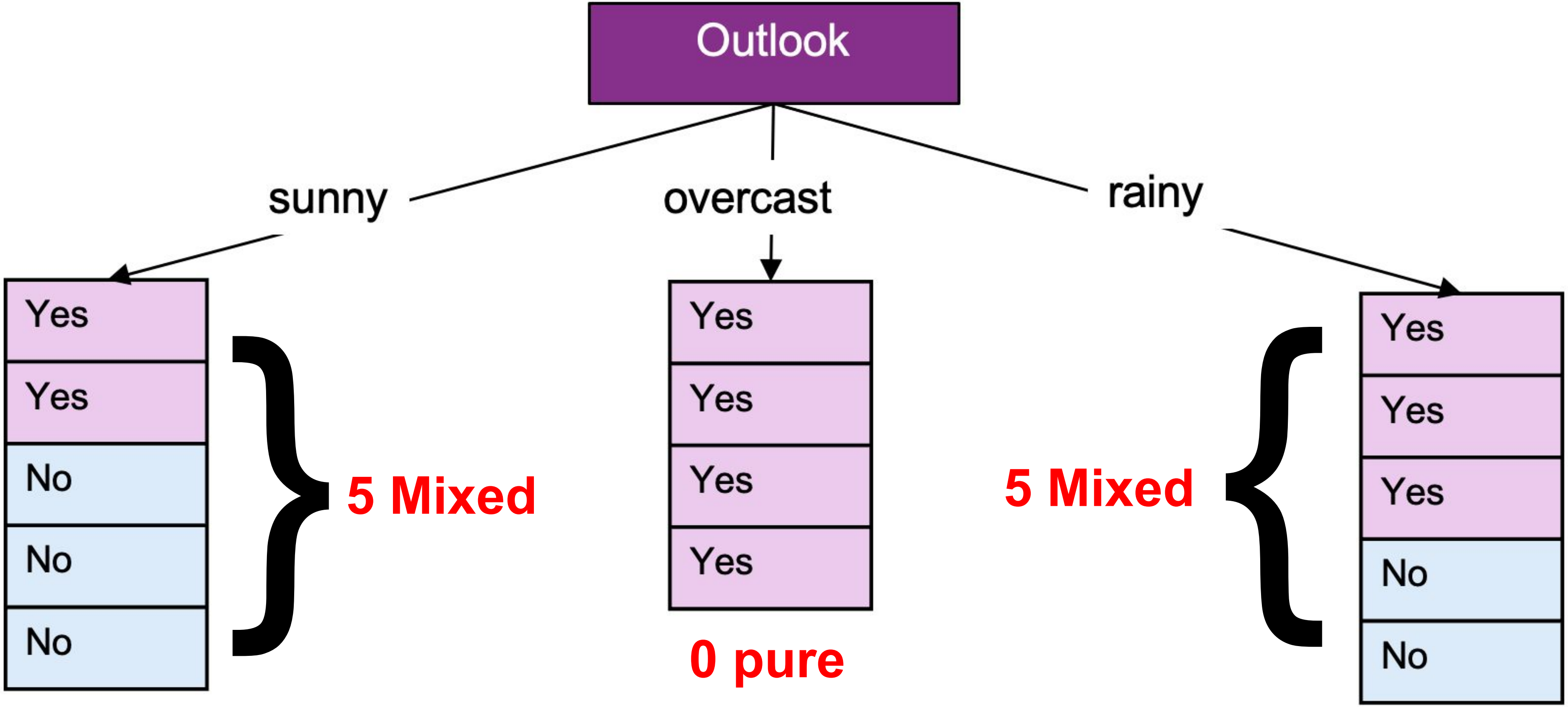
C. 10

D. 14

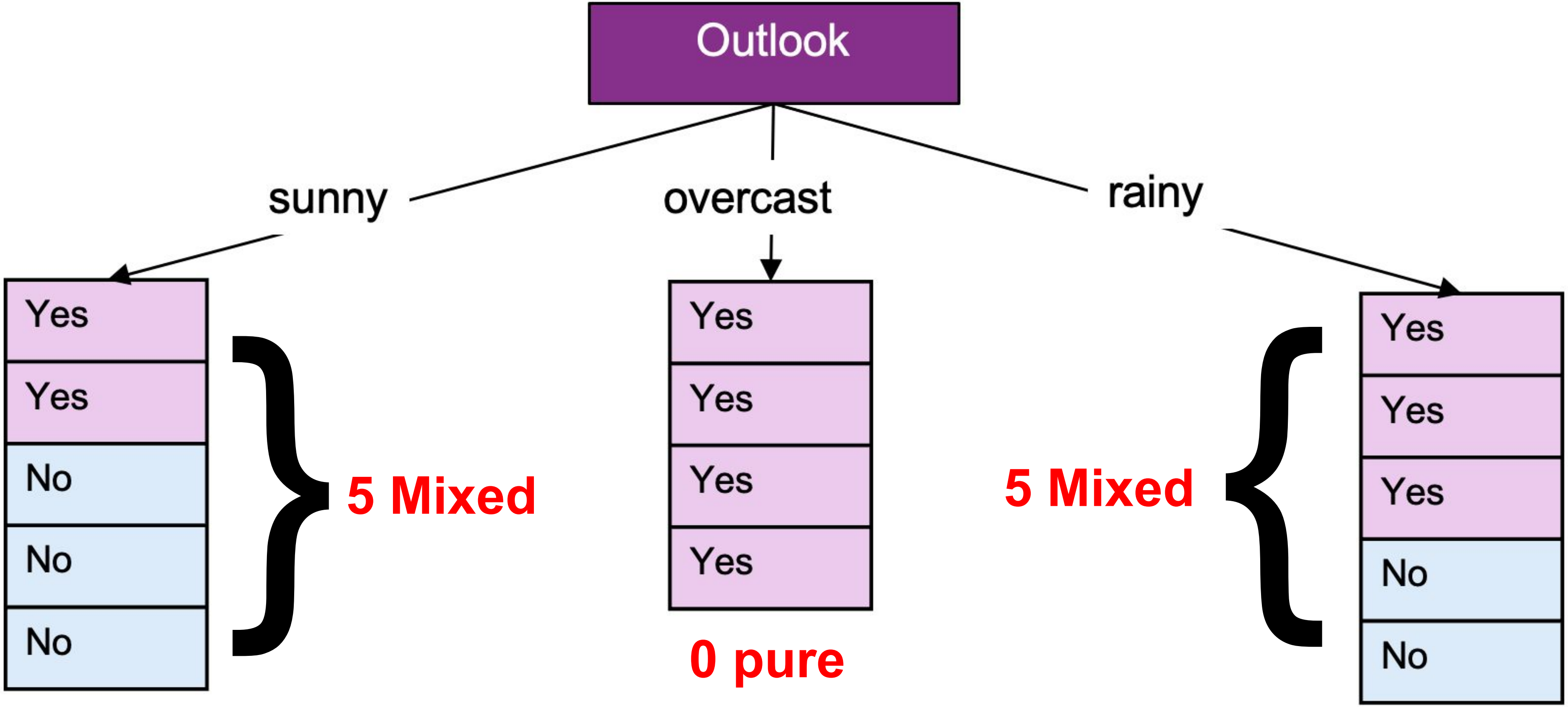
E. None of the above

Outlook	Temperature	Humidity	Windy	Play?
sunny	hot	high	false	No
sunny	hot	high	true	No
overcast	hot	high	false	Yes
rain	mild	high	false	Yes
rain	cool	normal	false	Yes
rain	cool	normal	true	No
overcast	cool	normal	true	Yes
sunny	mild	high	false	No
sunny	cool	normal	false	Yes
rain	mild	normal	false	Yes
sunny	mild	normal	true	Yes
overcast	mild	high	true	Yes
overcast	hot	normal	false	Yes
rain	mild	high	true	No

Q: What's the entropy if you split on Outlook?



Overall entropy = 5 + 0 + 5 = 10

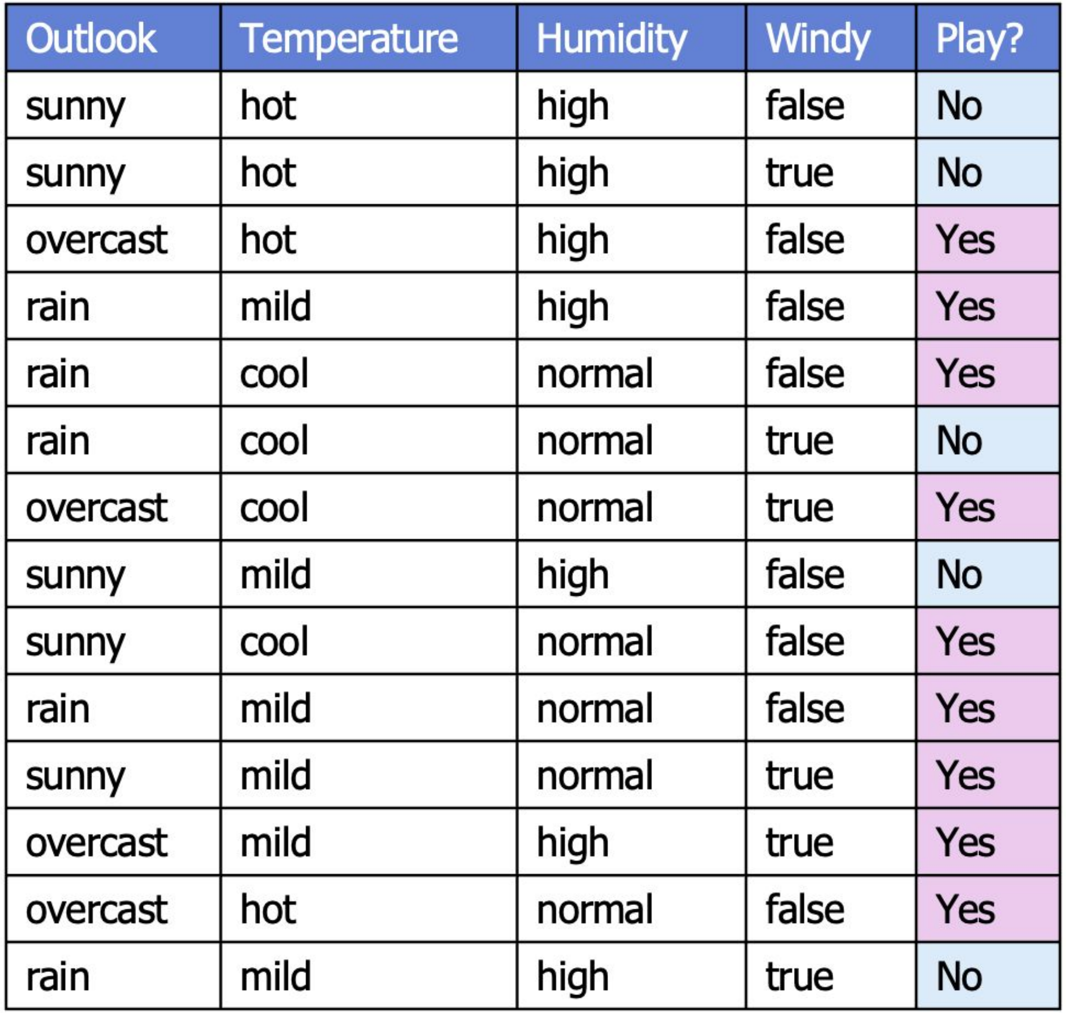


5 Mixed

0 pure

5 Mixed

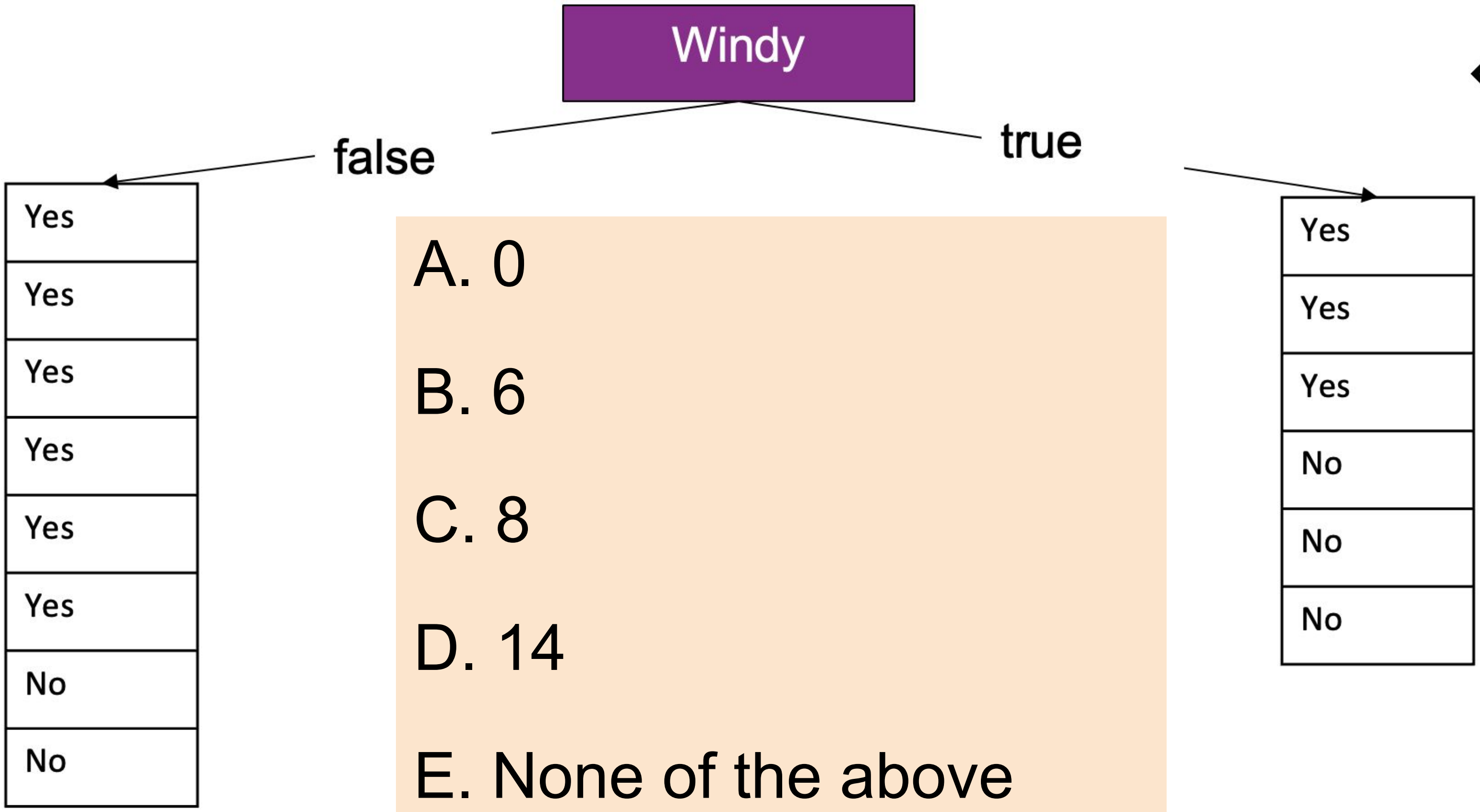
What’s the entropy if you split on Windy?



Outlook	Temperature	Humidity	Windy	Play?
sunny	hot	high	false	No
sunny	hot	high	true	No
overcast	hot	high	false	Yes
rain	mild	high	false	Yes
rain	cool	normal	false	Yes
rain	cool	normal	true	No
overcast	cool	normal	true	Yes
sunny	mild	high	false	No
sunny	cool	normal	false	Yes
rain	mild	normal	false	Yes
sunny	mild	normal	true	Yes
overcast	mild	high	true	Yes
overcast	hot	normal	false	Yes
rain	mild	high	true	No

Q: What’s the entropy if you split on Windy?

iClicker



A. 0

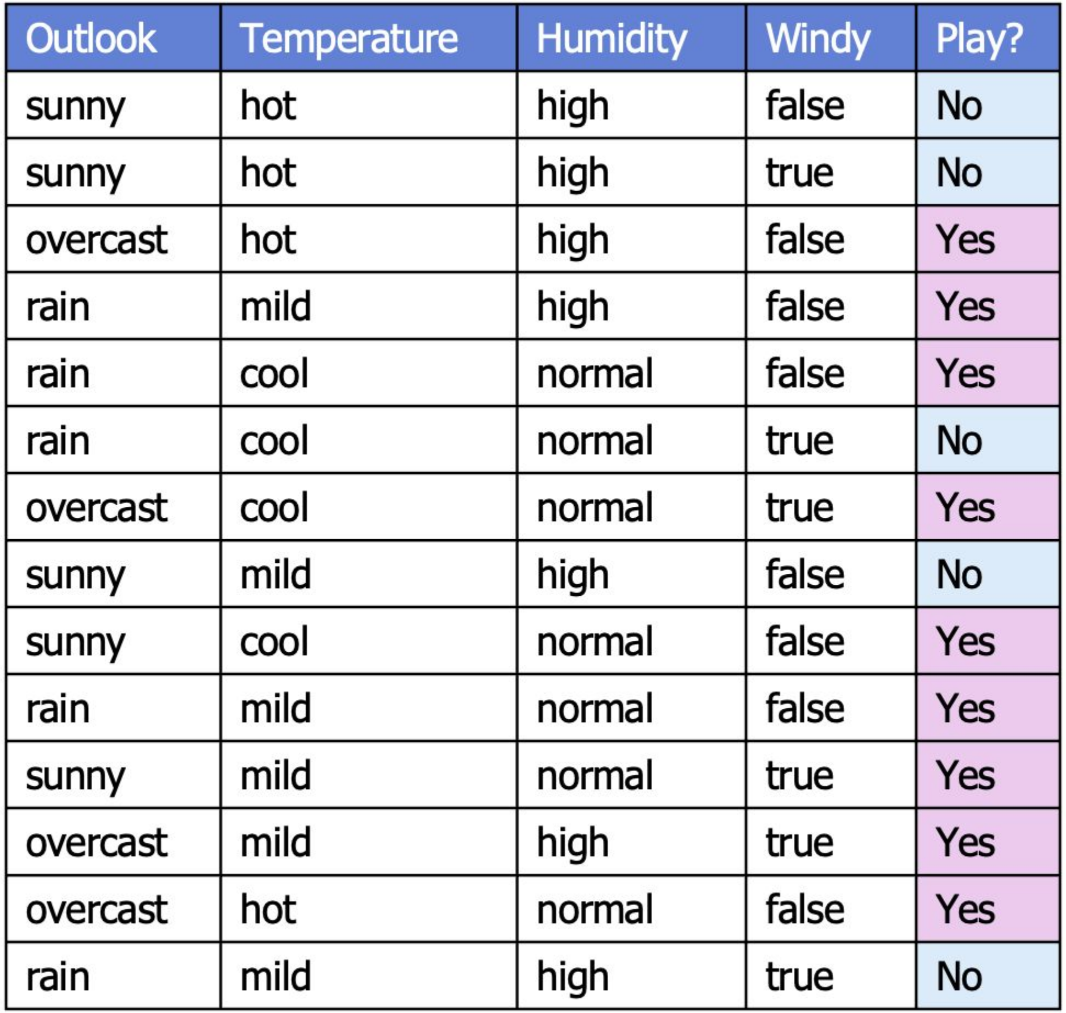
B. 6

C. 8

D. 14

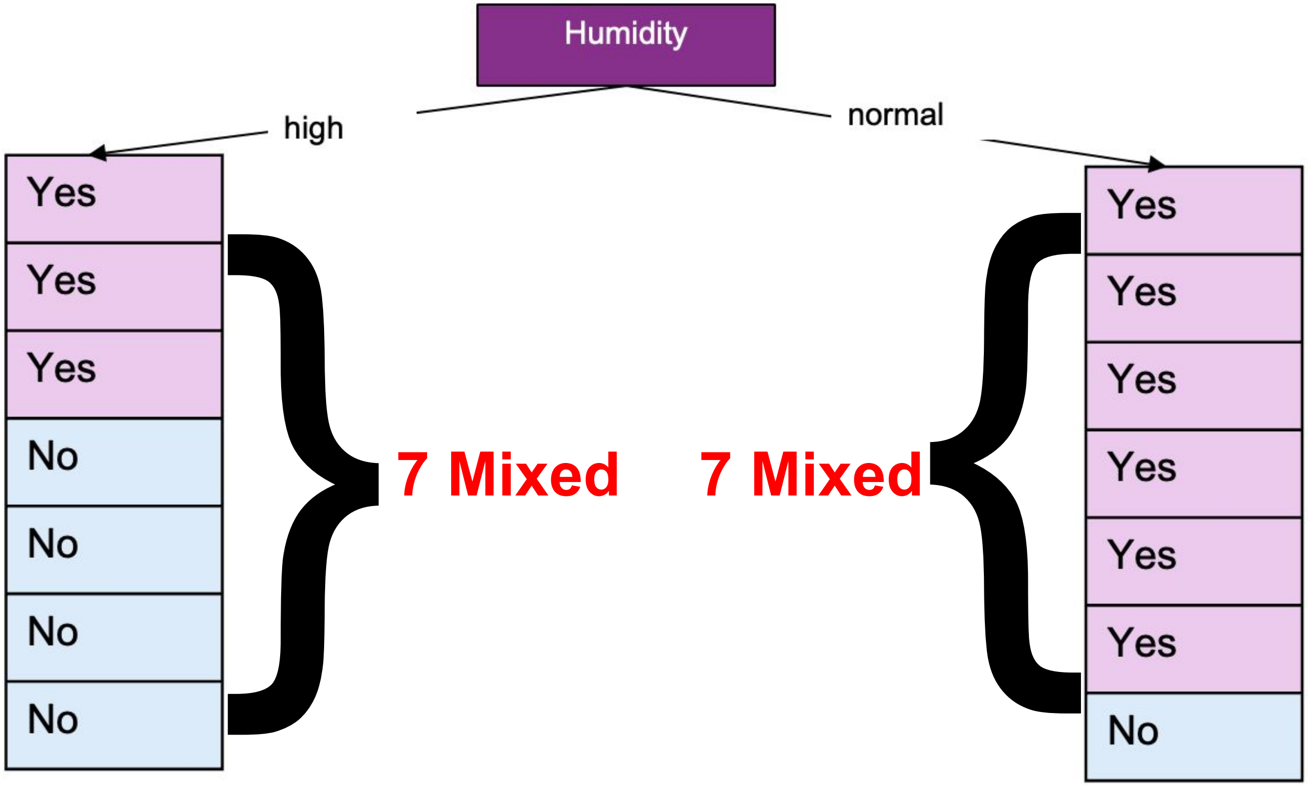
E. None of the above

What's the entropy if you split on Humidity?

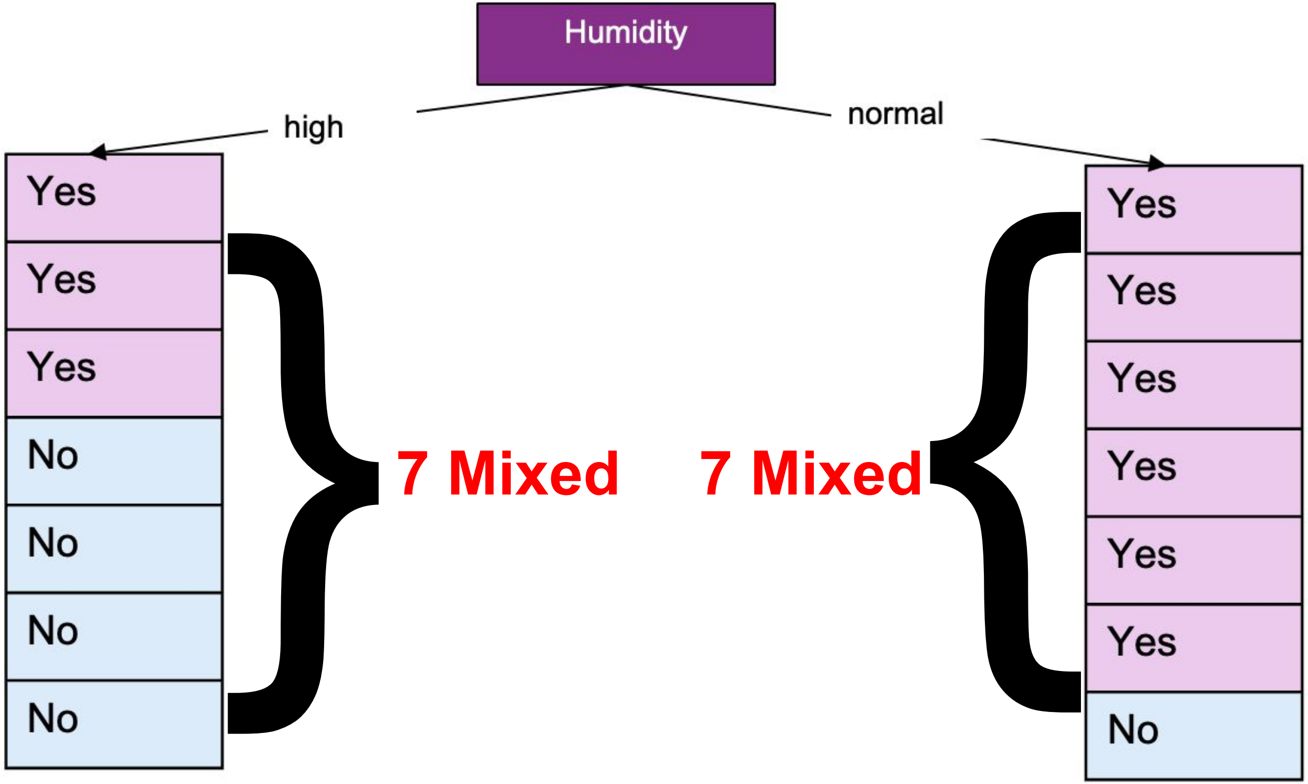


Outlook	Temperature	Humidity	Windy	Play?
sunny	hot	high	false	No
sunny	hot	high	true	No
overcast	hot	high	false	Yes
rain	mild	high	false	Yes
rain	cool	normal	false	Yes
rain	cool	normal	true	No
overcast	cool	normal	true	Yes
sunny	mild	high	false	No
sunny	cool	normal	false	Yes
rain	mild	normal	false	Yes
sunny	mild	normal	true	Yes
overcast	mild	high	true	Yes
overcast	hot	normal	false	Yes
rain	mild	high	true	No

Q: What’s the entropy if you split on Humidity?



Overall entropy = 7 +7 = 14



Recap

What is the best attribute to split on?

- Entropy if we split on Temperature = 14
- Entropy if we split on Outlook = 10
- Entropy if we split on Windy = 14
- Entropy if we split on Humidity = 14

Why? It does the best job of **reducing** entropy

What is the best attribute to split on?

- Entropy if we split on Temperature = 14
- **Entropy if we split on Outlook = 10**
- Entropy if we split on Windy = 14
- Entropy if we split on Humidity = 14

Why? It does the best job of **reducing** entropy

Wrap up

Wrap Up

- **Lab #2**
  - Due on Friday, Jan 24 at 11:59pm
- **Post-Class (PC) Quiz #1**
  - Only 1 attempt, 60 minutes
  - Open book, open-AI* (*you must disclosure your usage)
  - Due on Sunday, Jan 26 at 11:59pm
- **Group Contracts**
  - Extended to Monday, Jan 27 at 11:59pm
- **PC Quiz #2**
  - To be released next week!