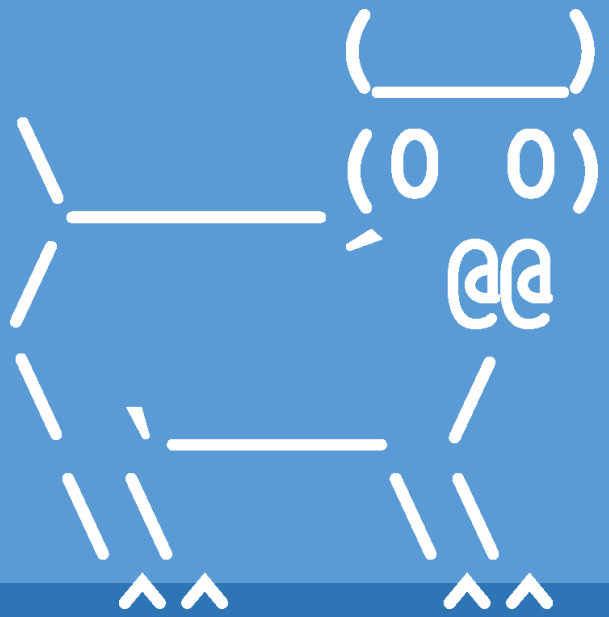
Binary Trees



Introduction to Computer Science

Iris Howley

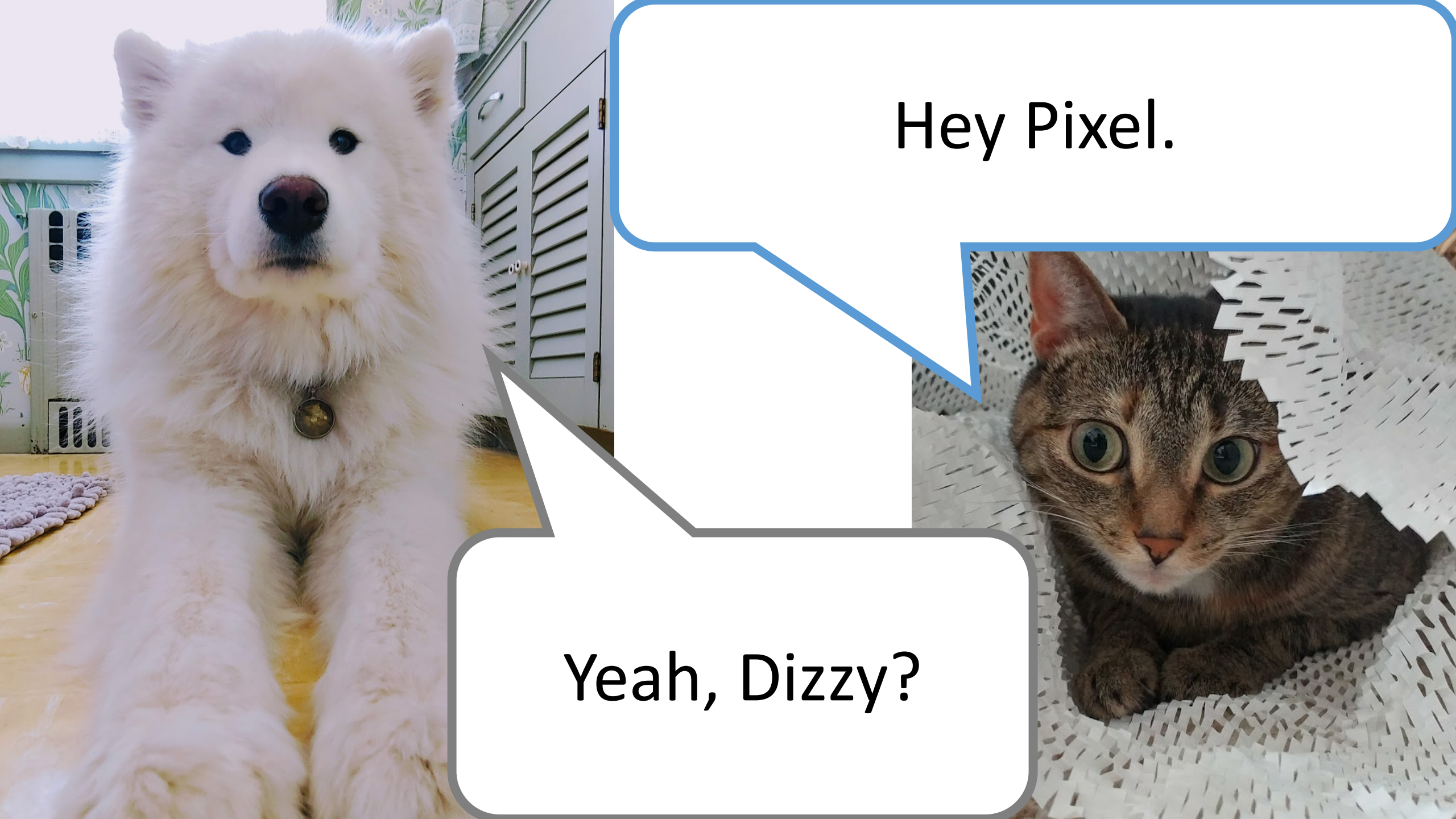
TODAY'S LESSON

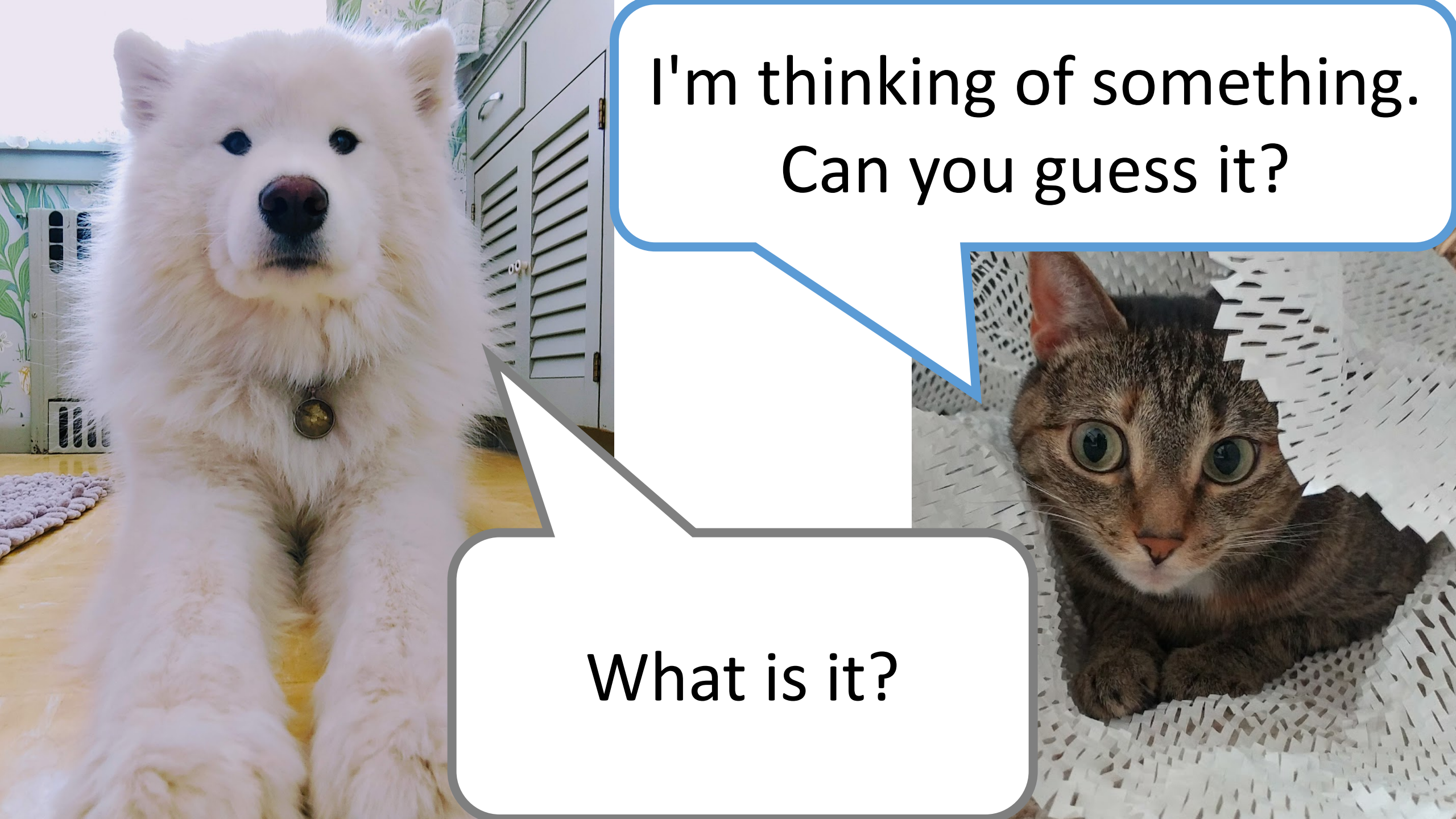
Binary Trees

(A data structure for holding a different sort of data)

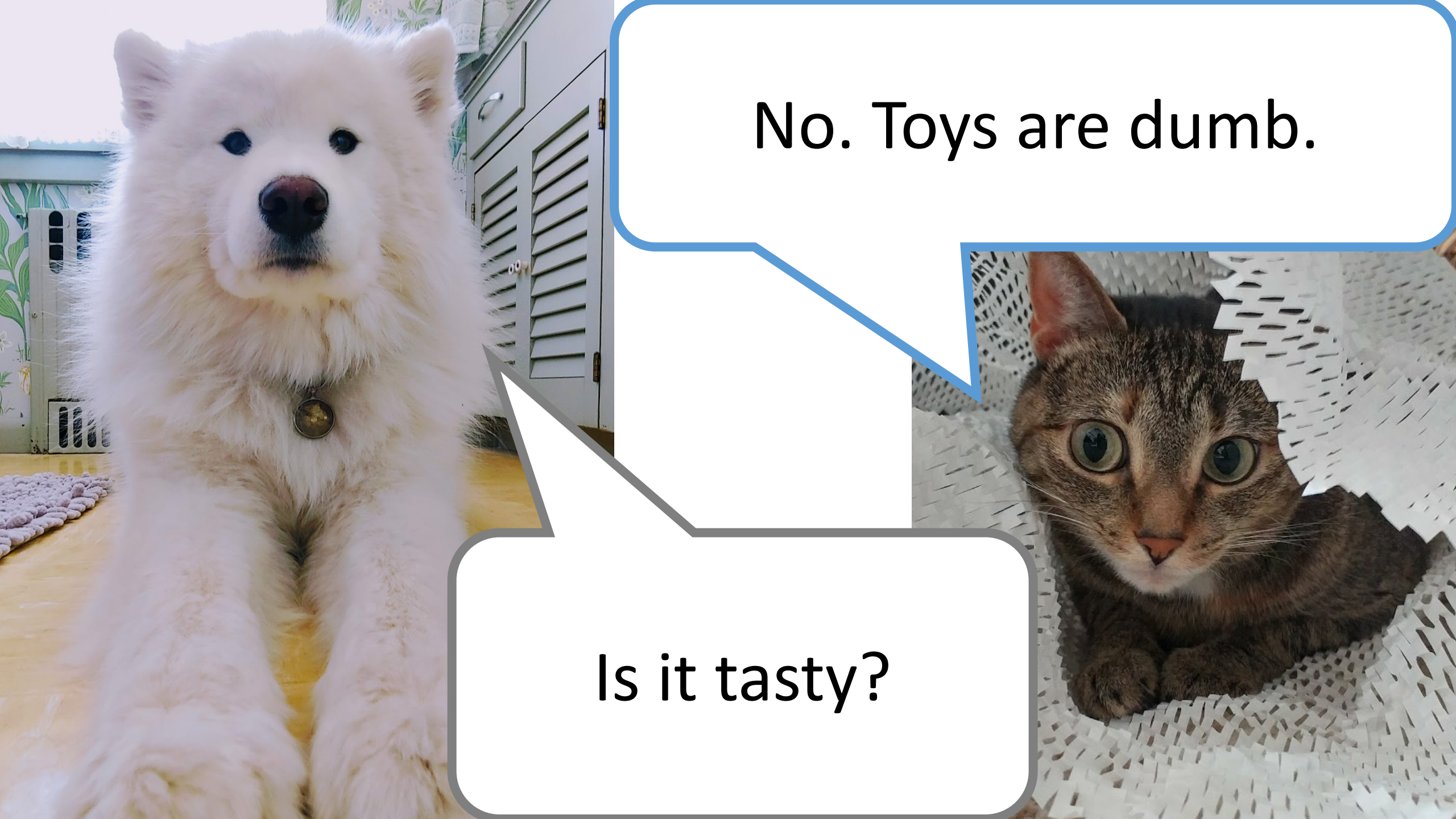
GAME: TWENTY QUESTIONS

- The "Knower" thinks of a noun
- The "Guesser(s)" ask yes/no questions in an attempt to guess the noun
- The Knower responds with only yes/no answers
- The Guesser aims to find the Knower's noun with fewer than 20 questions.

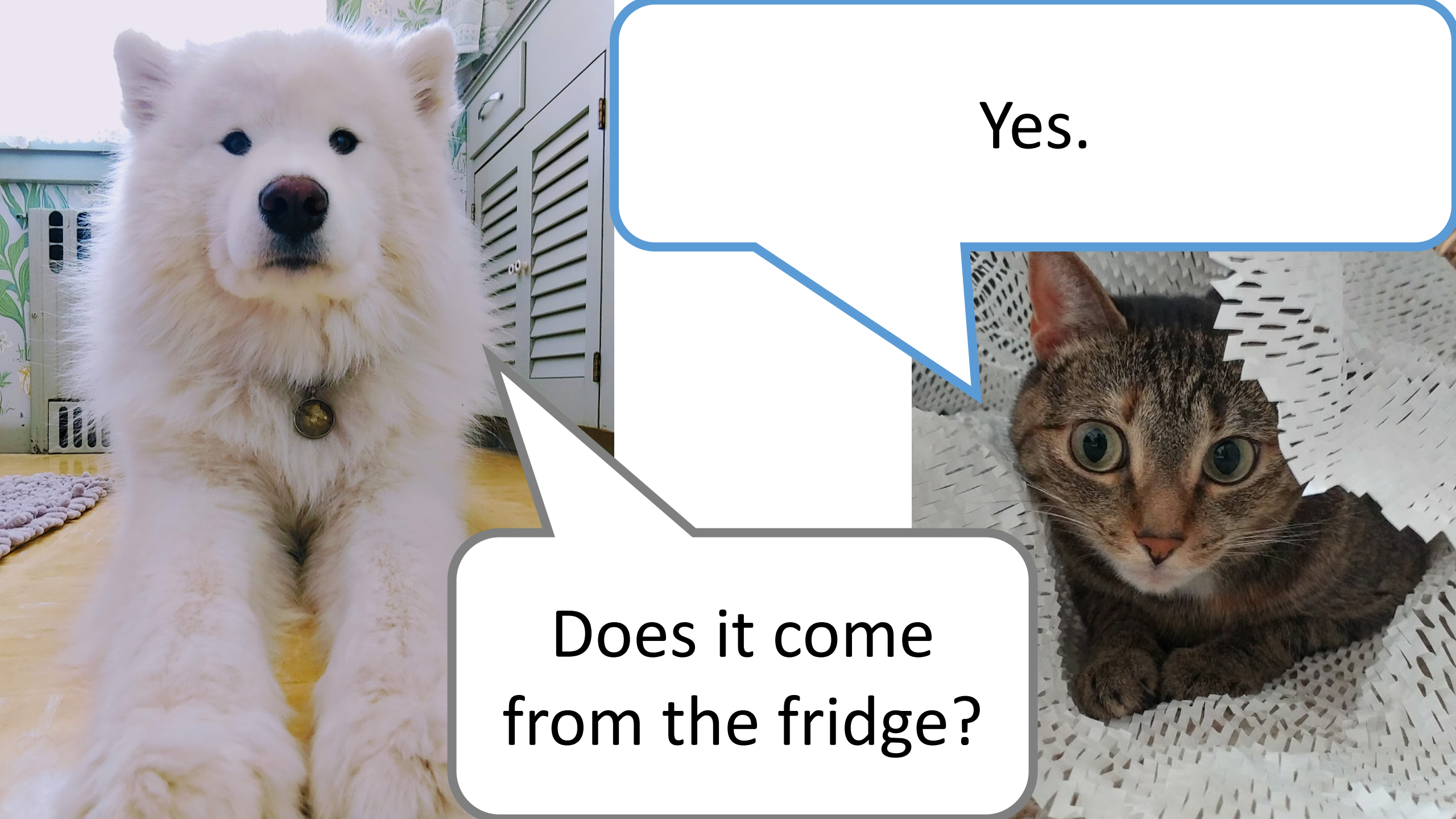

Hey Pixel.
Yeah, Dizzy?

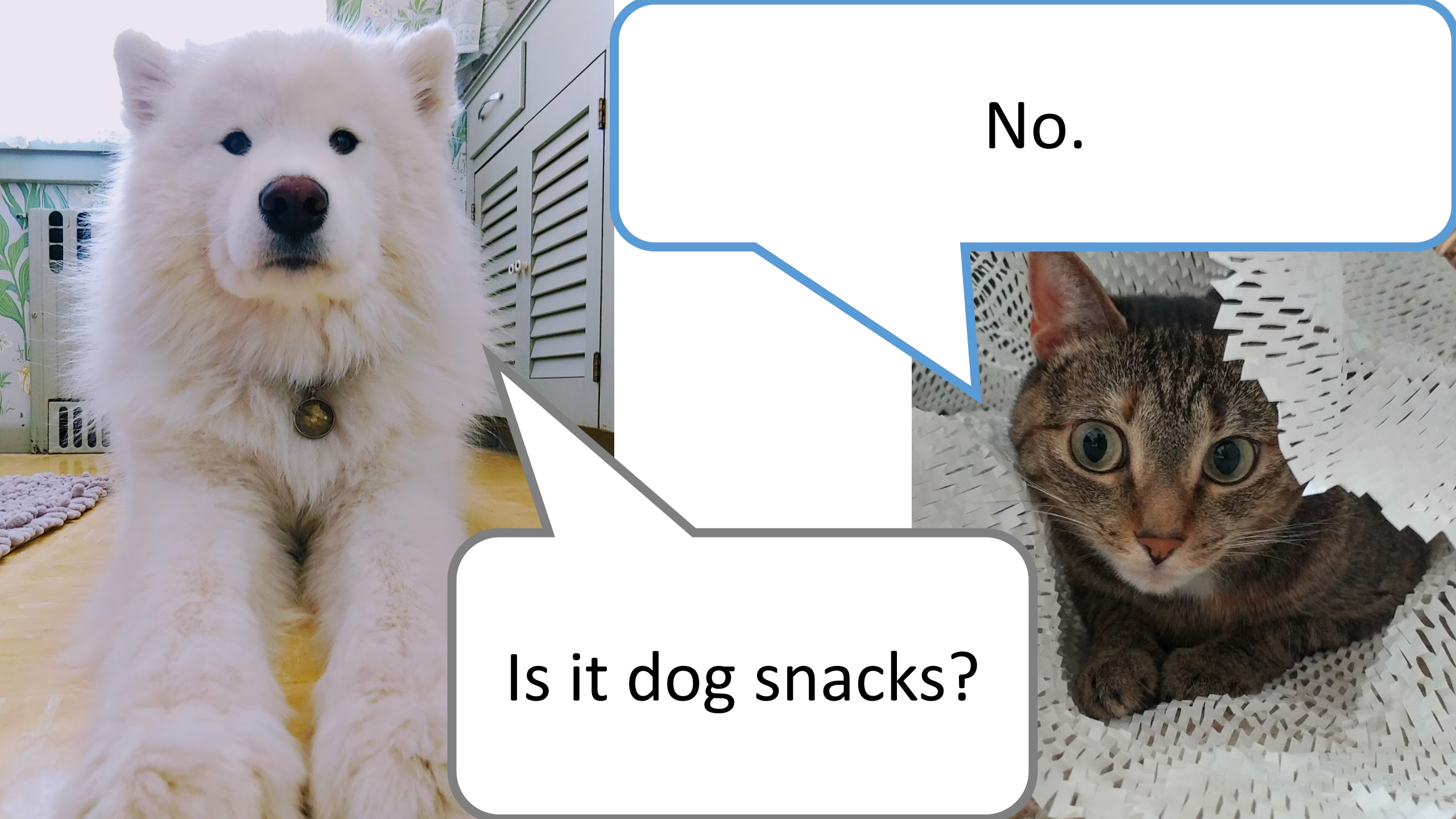

I'm thinking of something.
Can you guess it?
What is it?

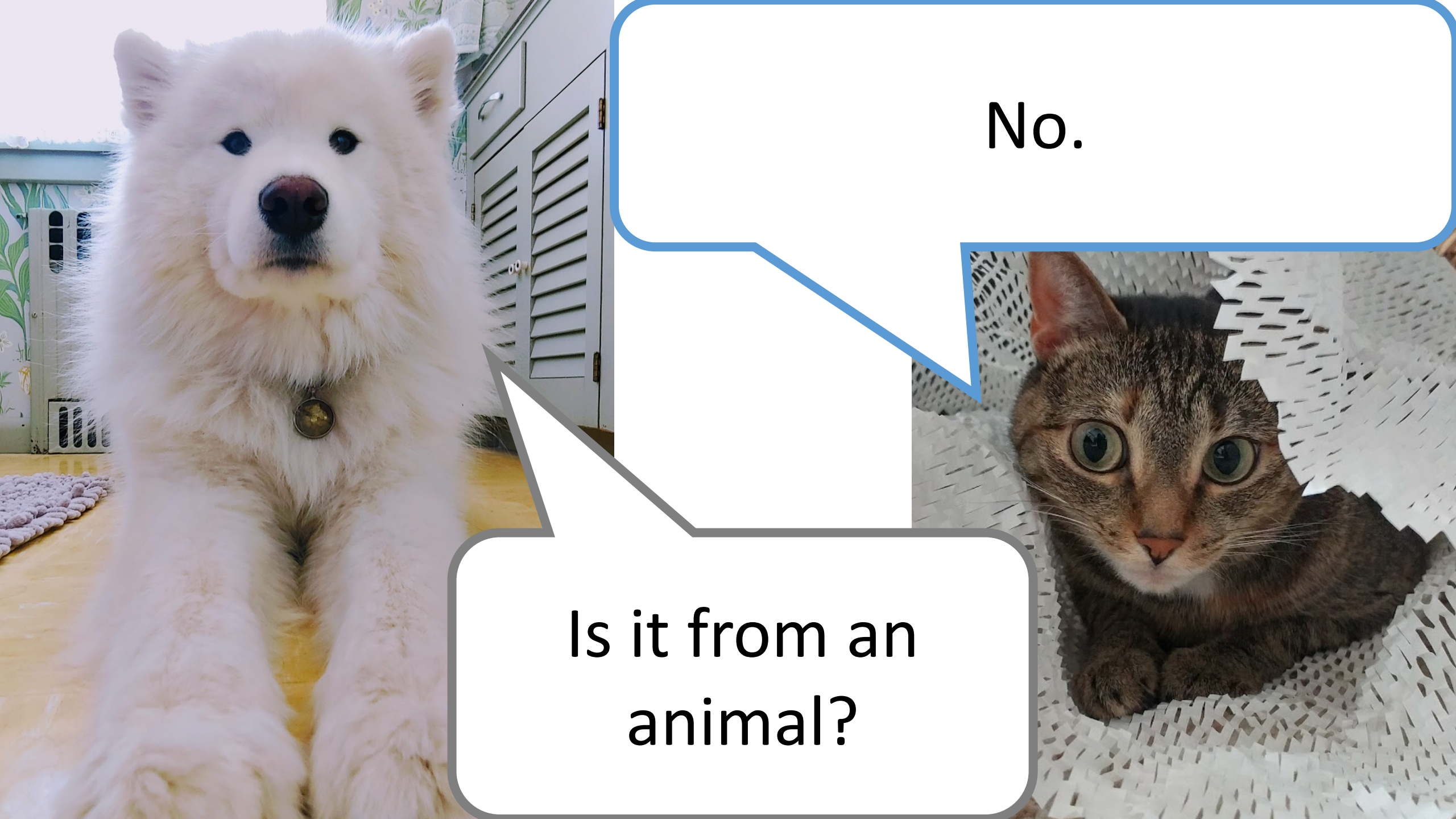

Yes/No questions only.
Okay, is it a toy?

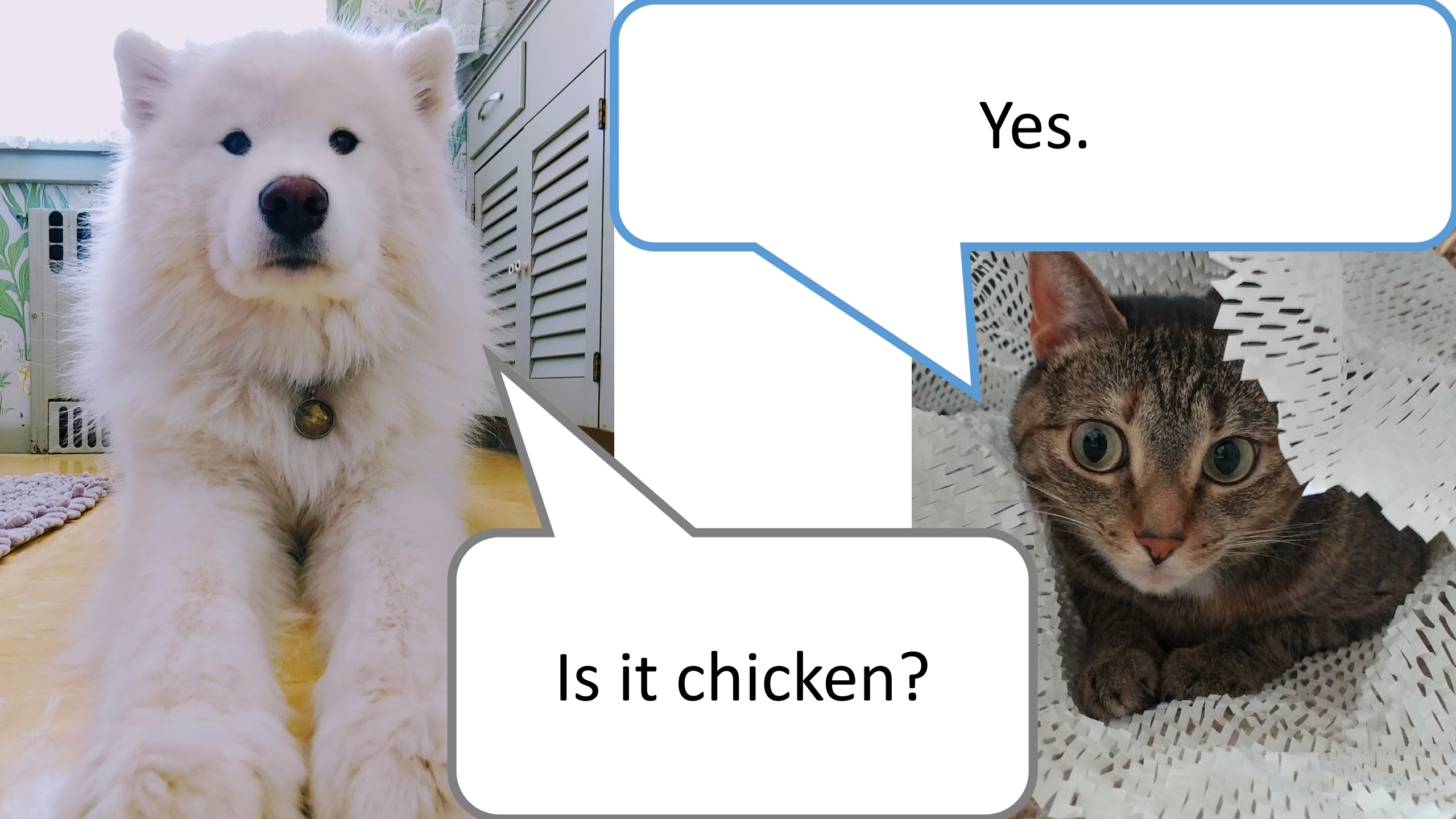

No. Toys are dumb.
Is it tasty?

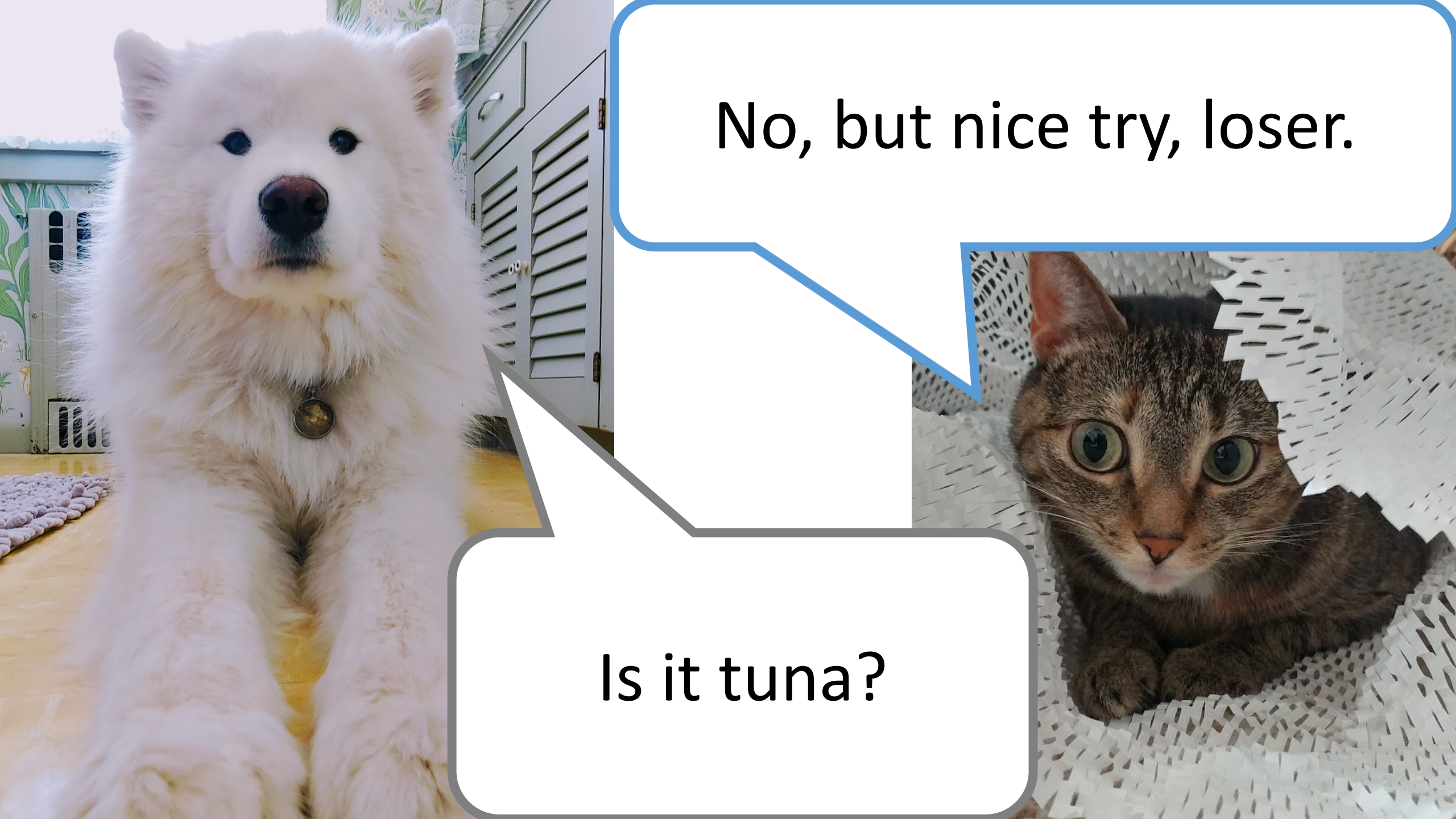

Yes.
Is it savory?


Yes.
Does it come from the fridge?


No.
Is it dog snacks?

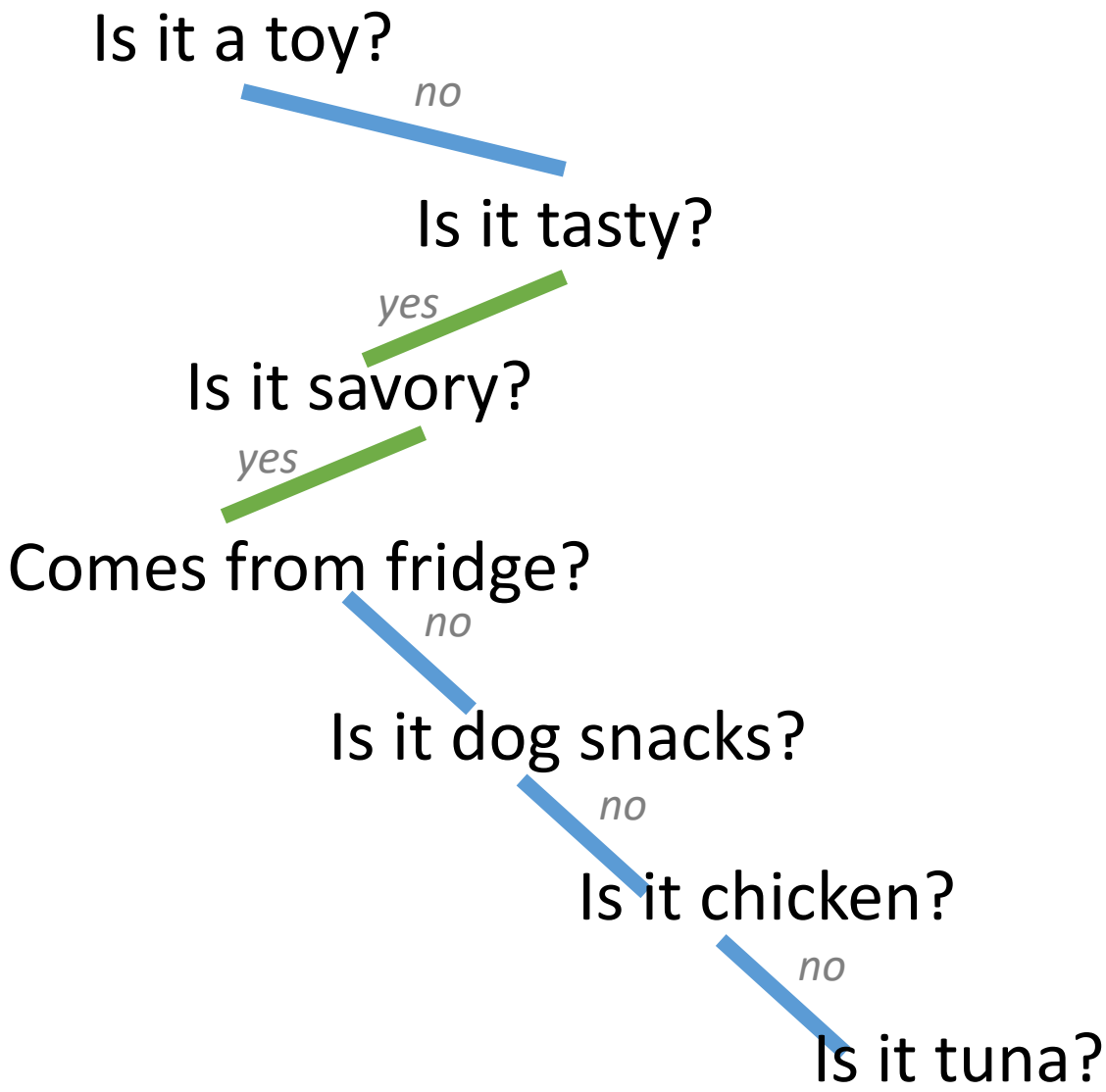

No.
Is it from an animal?


Yes.
Is it chicken?

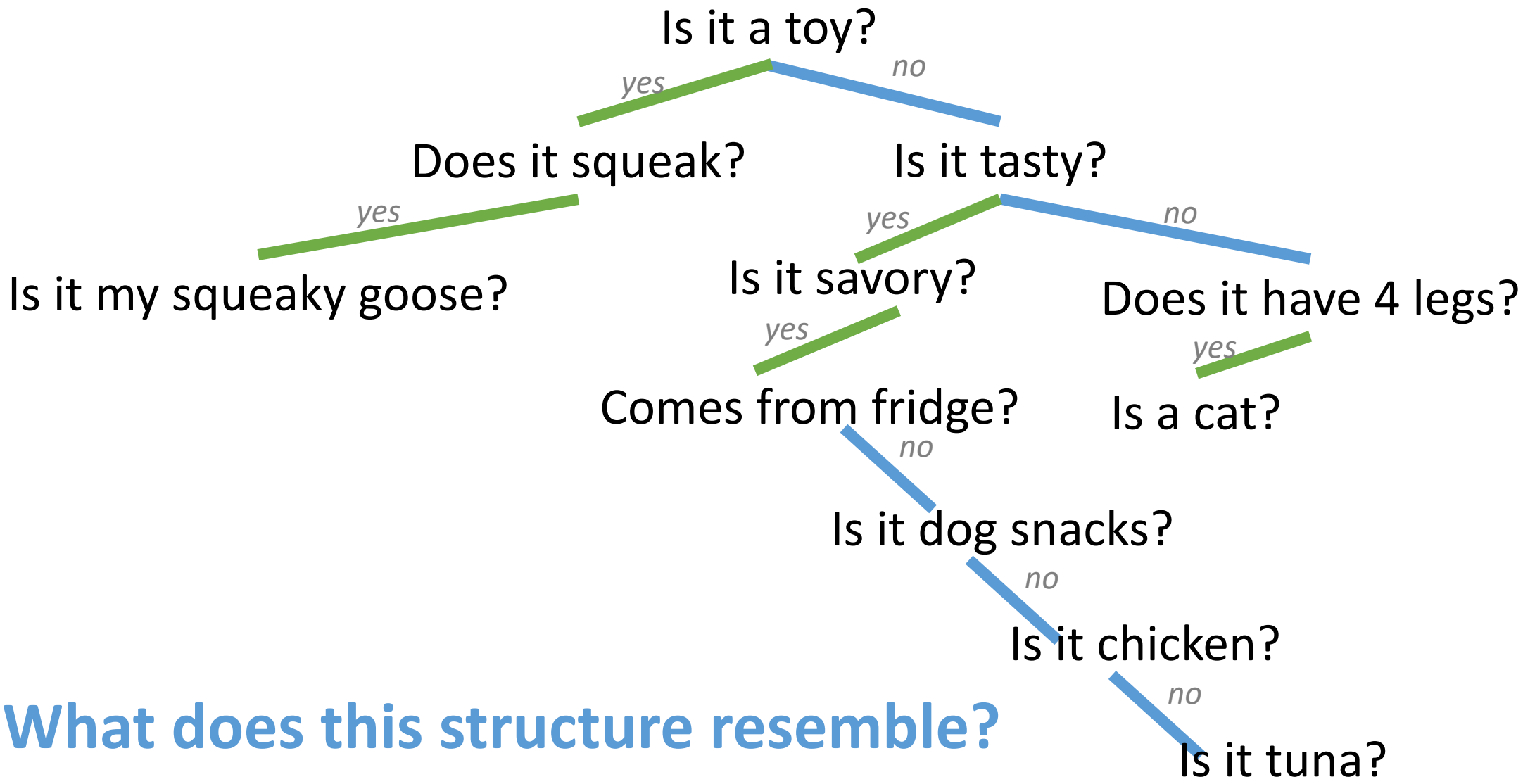

No, but nice try, loser.
Is it tuna?


YASSSSSSSSSSSSSSS.
I'm a winner?

Twenty Questions

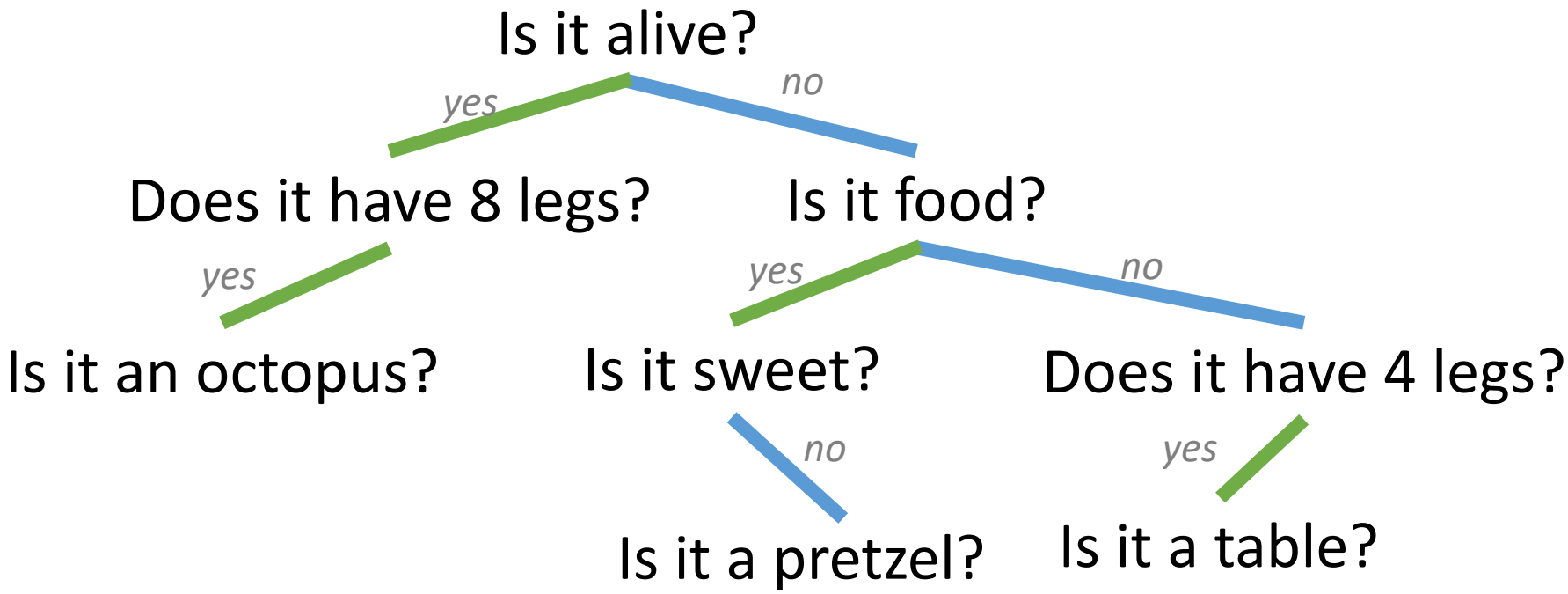


Twenty Questions



What does this structure resemble?

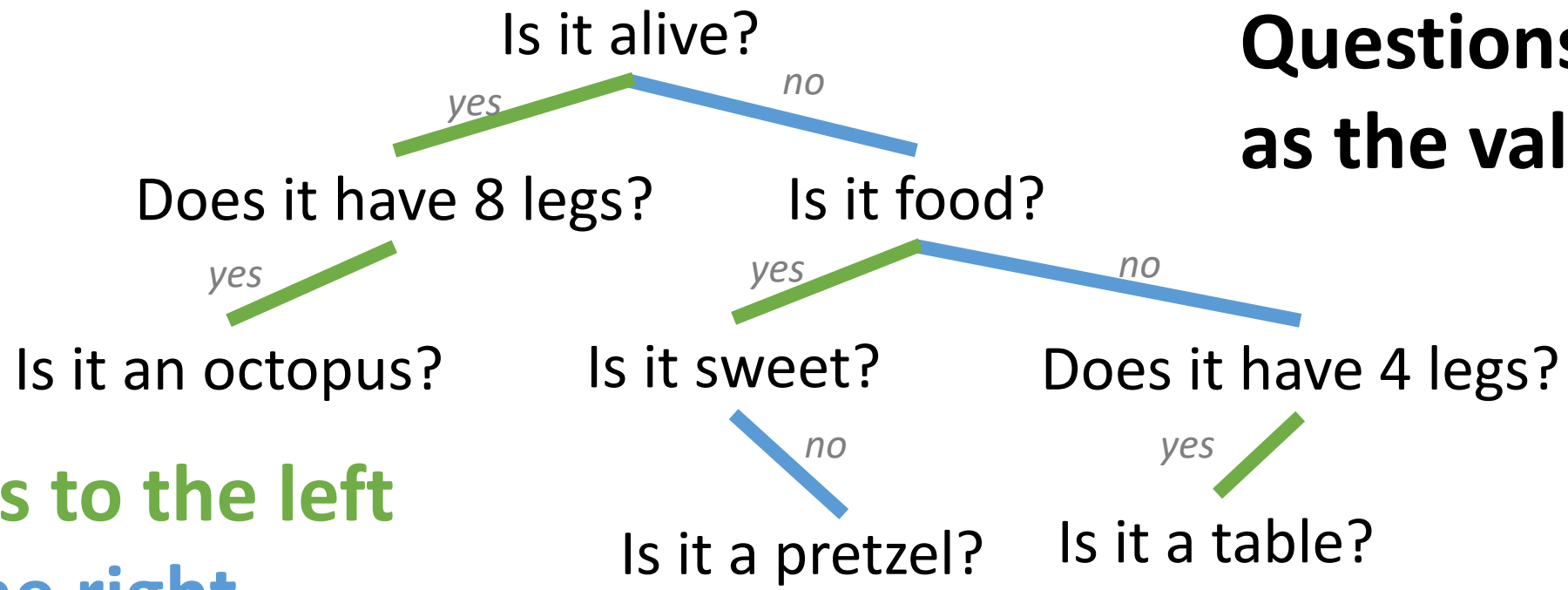
Twenty Questions



A more balanced game might be clearer…

Twenty Questions Tree

```
__slots__ = [_value, _left, _right]
```



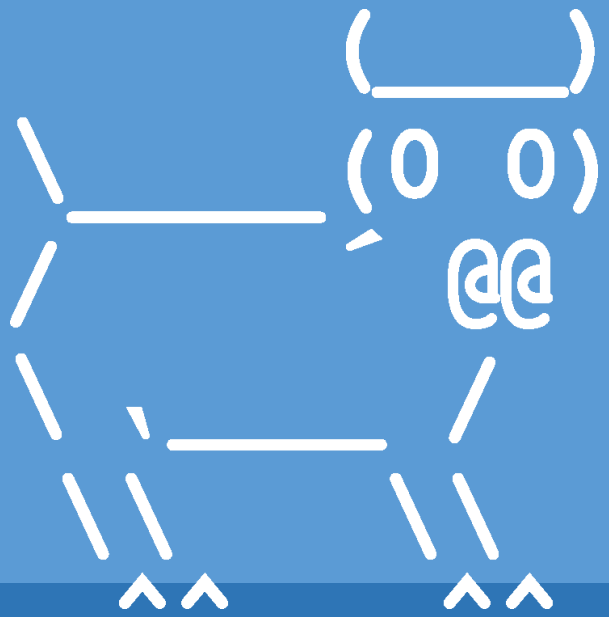
Questions stored as the value

‘yes’ goes to the left
‘no’ to the right

If it’s a leaf, it’s a guess

Please contact me!

Building Binary Trees



Introduction to Computer Science

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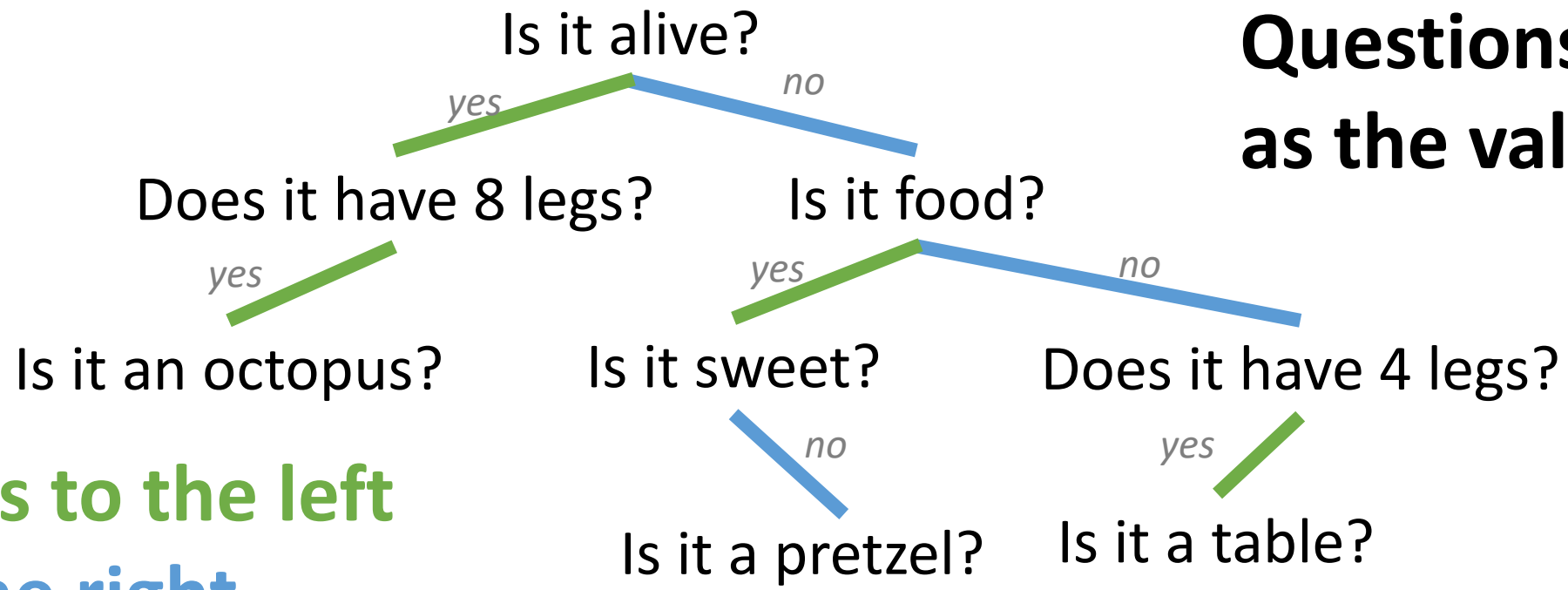
TODAY'S LESSON

Binary Trees

(A data structure for holding a different sort of data)

Twenty Questions Tree

```
__slots__ = [_value, _left, _right]
```



Questions stored as the value

‘yes’ goes to the left
‘no’ to the right

If it’s a leaf, it’s a guess

Creating a Tree

- `t2       = Tree('Does it have 8 legs?')`
- `t3       = Tree('Is it food?')`
- `mytree   = Tree('Is it alive?', t2, t3)`

Adding Nodes to the Tree

- Octopus?
- `t4 = ("octopus?")`
- → `t2 = Tree('8 legs?',t4)`

Accessing Nodes in a Tree

- `print(mytree.value)` `'Is it alive?'`
- `print(mytree.left.value)` `'Does it have 8 legs?'`
- `print(mytree.left.left.value)` `'Is it an octopus?'`

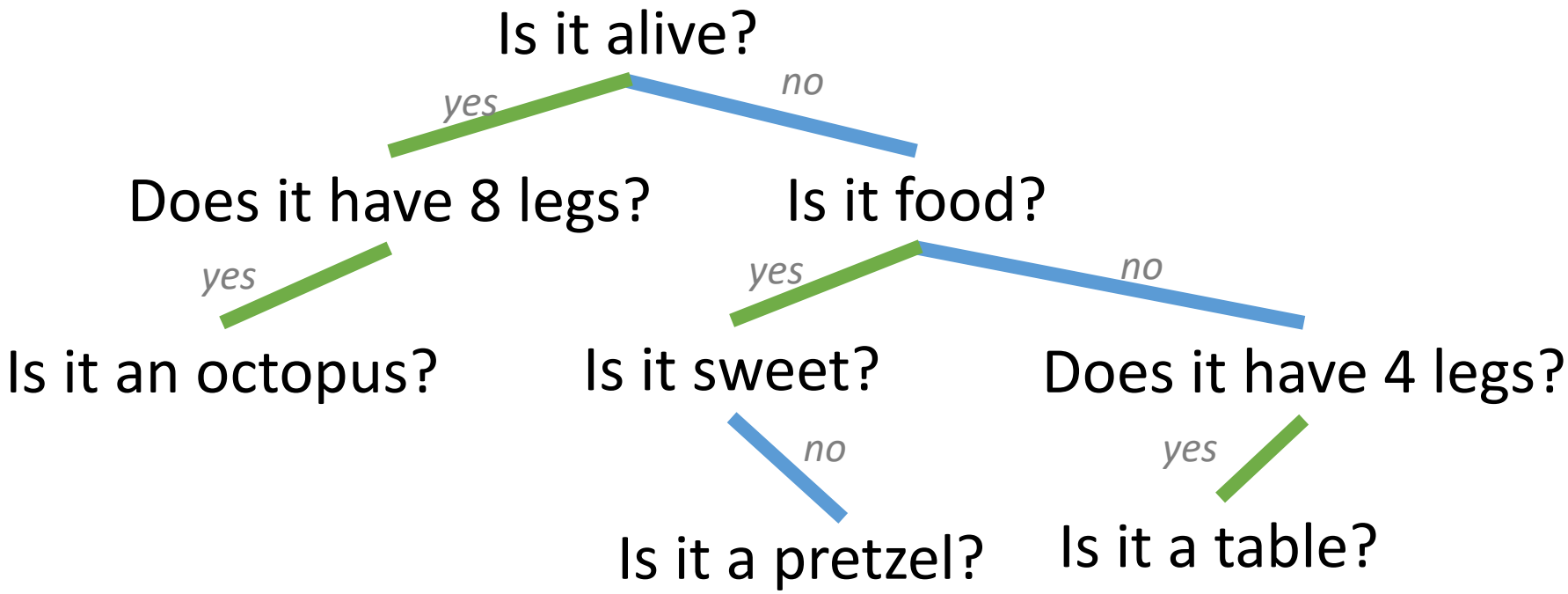
What does this code do?

```
def mystery(self):
        if not self.right:
            return self

        return self.right.mystery()
```

See POGIL 45 on Binary Trees!

Twenty Questions Tree



Binary Tree

- Let's write a `contains(..)` method for a tree
  - (Application Question #3 from POGIL #45)

```
>>> from tree import *
>>> mytree = Tree(99, Tree(33), Tree(66))
>>> 66 in mytree
True        # __contains__() is implicitly called with "if ___ in <sequence>"
>>> 24 in mytree
False
```

Steps for Recursion

1. Know when to stop.
2. Decide how to take one, repeated step.
3. Break the journey down into that step plus a smaller journey.

Recursive Approach

- **REDUCE** the problem to smaller subproblem(s) (smaller version(s) of itself)
- **DELEGATE** the smaller problems to the recursion fairy ***(formally known as induction hypothesis)*** and assume they're solved correctly
- **COMBINE** the solution(s) of the smaller subproblems to reach/return the solution

Contains Method for `Tree`

- Stopping/Base Case:
  1. We've found the value
  2. Or we're a leaf!

- Small step
  - Check if we're the value

- Break the journey down
  - Check the left child, then the right (if it's not in the left side)

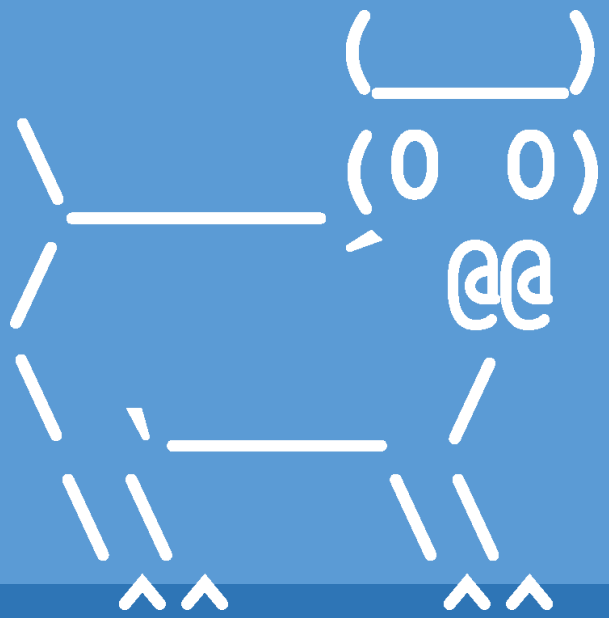
Contains Method for `tree`

```
# __contains__() is implicitly called with "if ___ in <sequence>"
def __contains__(self, v):
 # Base case
 if self.value == v:
    return True

 l = v in self.left if self.left else False
 r = v in self.right if not l and self.right else False
 # if not l lets us skip the right side, if we found it in the left already
 return l or r
```

Please contact me!

Using Binary Trees



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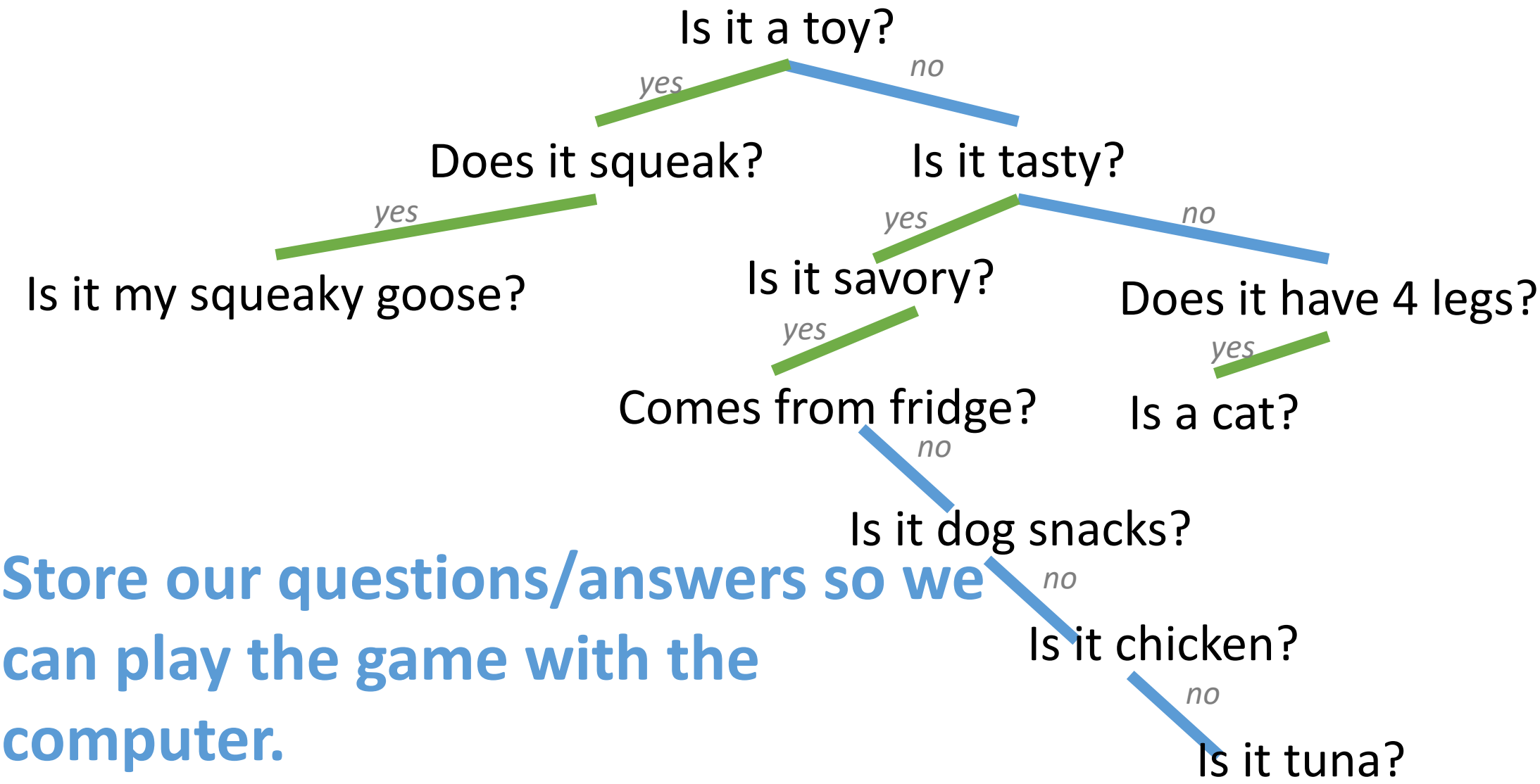
TODAY'S LESSON

Using a Binary Tree

(Let's use our new data structure for something fun!)

Twenty Questions Tree



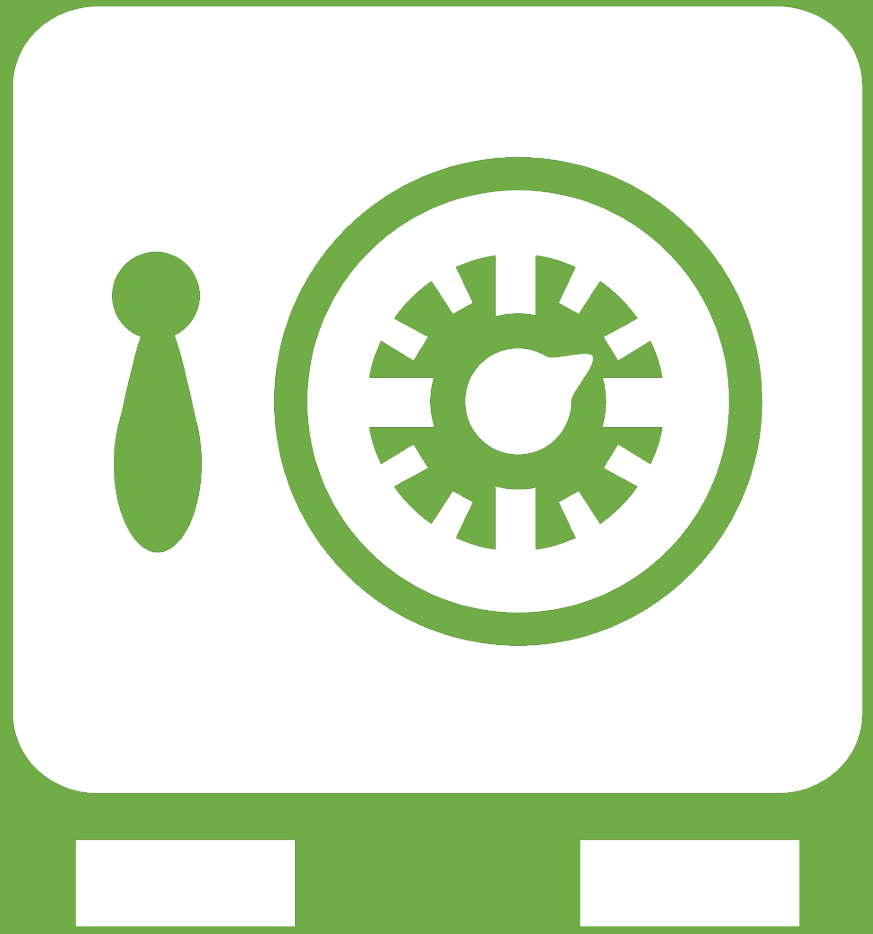
Store our questions/answers so we can play the game with the computer.

q20.py

A program to play 20 Questions, using our tree data structure

See q20.py on the course website.

Please contact me!



Leftover Slides

Steps for Recursion

- Know when to stop.
- Decide how to take one step.
- Break the journey down into that step plus a smaller journey.

`__str__` versus `__repr__`

- `__str__` returns a *human*-readable string representation of the object
  - Implicitly called with `print(object)` or `str(object)`
  - Also called with `'{!s}'.format(object)` in a format string

- `__repr__` produces a *machine*-readable string representation of the object
  - Implicitly called in interactive python: `>>> object`
  - Also called with `'{!r}'.format(object)` in a format string

OBJECT PERSISTENCE

Storing objects for future use.

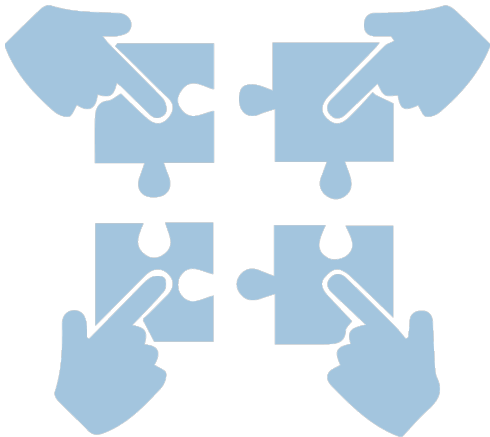
POGIL Activity #41 – object persistence

- Find a partner and spend a few minutes discussing your responses to the POGIL worksheet, Question **1-3**.

- Be prepared to report out your responses!

This is a brand new POGIL activity,

let me know if you encounter any issues, typos, etc.



Time’s up!

Report out!

Object Persistence

HOW MIGHT THIS BE USEFUL FOR OUR GAME OF TWENTY QUESTIONS?