FoCS:

Markov Chains, Dictionaries, and Files

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UC San Diego SPIS 2019

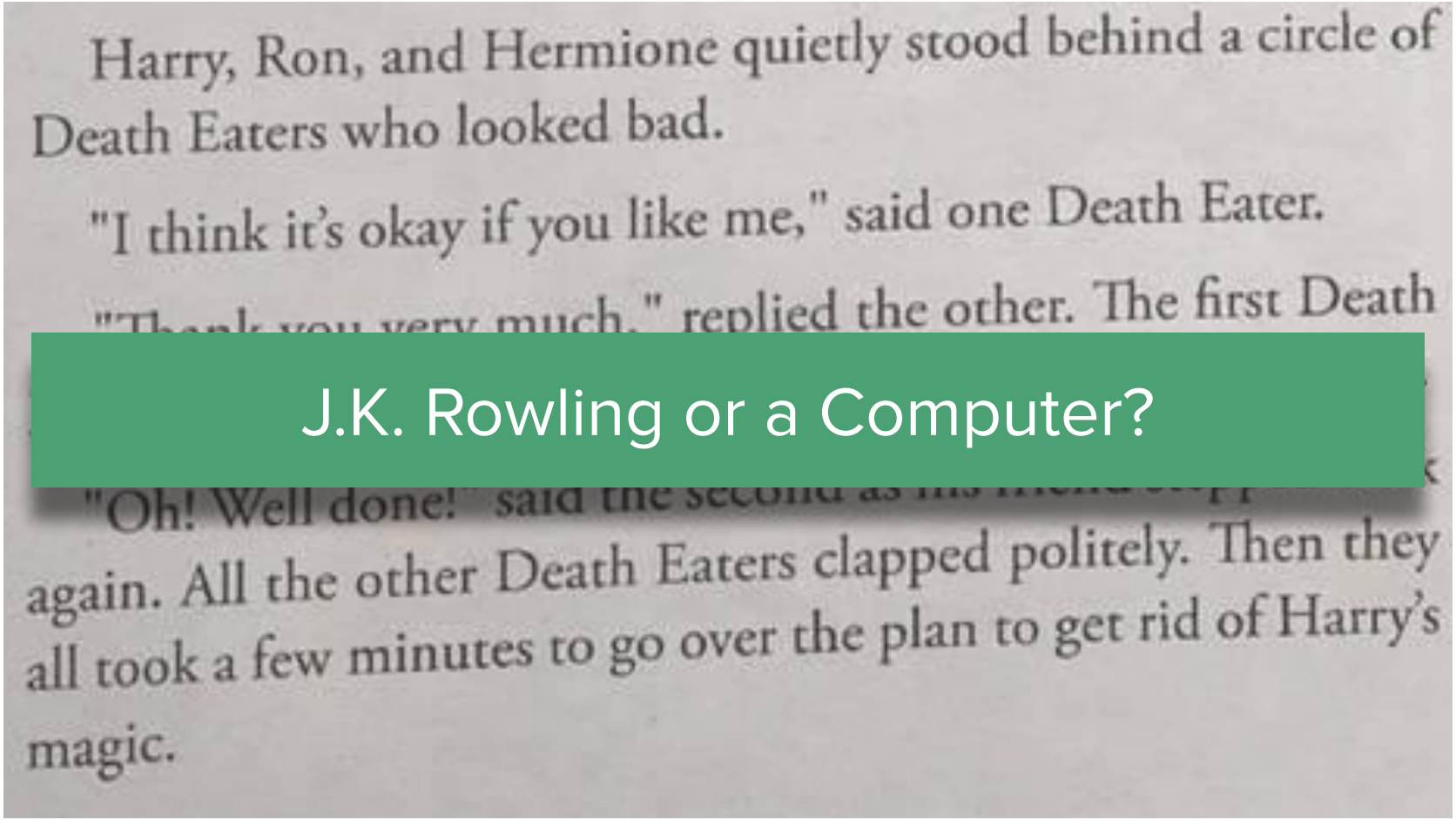
Programs that can **write**

Harry, Ron, and Hermione quietly stood behind a circle of Death Eaters who looked bad.

"I think it's okay if you like me," said one Death Eater.

"Thank you very much," replied the other. The first Death Eater confidently leaned forward to plant a kiss on his cheek.

"Oh! Well done!" said the second as his friend stepped back again. All the other Death Eaters clapped politely. Then they all took a few minutes to go over the plan to get rid of Harry's magic.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"I think it's okay if you like me," said one Death Eater.
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again. All the other Death Eaters clapped politely. Then they all took a few minutes to go over the plan to get rid of Harry's magic.
J.K. Rowling or a Computer?

Creating a Program to Write

- What would be a reasonable **first word** to start a sentence?

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- What would be a reasonable way to **end a sentence**?

Creating a Program to Write

- What would be a reasonable **first word** to start a sentence?
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- Can we learn these from reality?
- …
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Who Wrote What?

It's a dangerous business, _____, going out your door. You step onto the road, and if you don't keep your feet, there's no knowing where you might be swept off to.

Have you any idea how much tyrants fear the people they oppress? All of them realize that, one day, amongst their many victims, there is sure to be one that rises against them and strikes back!

It’s a gift to exist, and with existence comes suffering. There’s no escaping that. I don’t want it to have happened. I want it to not have happened, but if you are grateful for your life, then you have to be grateful for all of it.

No matter where you are, whether it's a quarter mile away or halfway across the world, you'll always be with me.

Bilbo Baggins (J.R.R. Tolkien)

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Stephen Colbert

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Dom Toretto (Fast & Furious)

Mathematical Models

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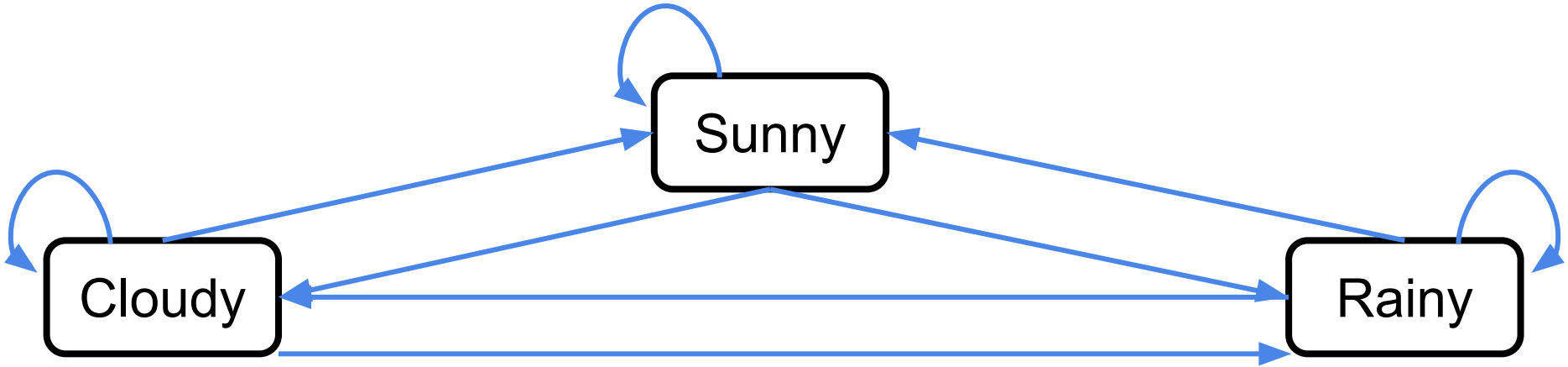
- A **probabilistic model** is a mathematical model with randomness
- We can **train** a probabilistic model to try to capture reality
    - Can we design a probabilistic model to learn writing style?

Markov Chains

- **Markov Chains:** A probabilistic model defined by states & transitions



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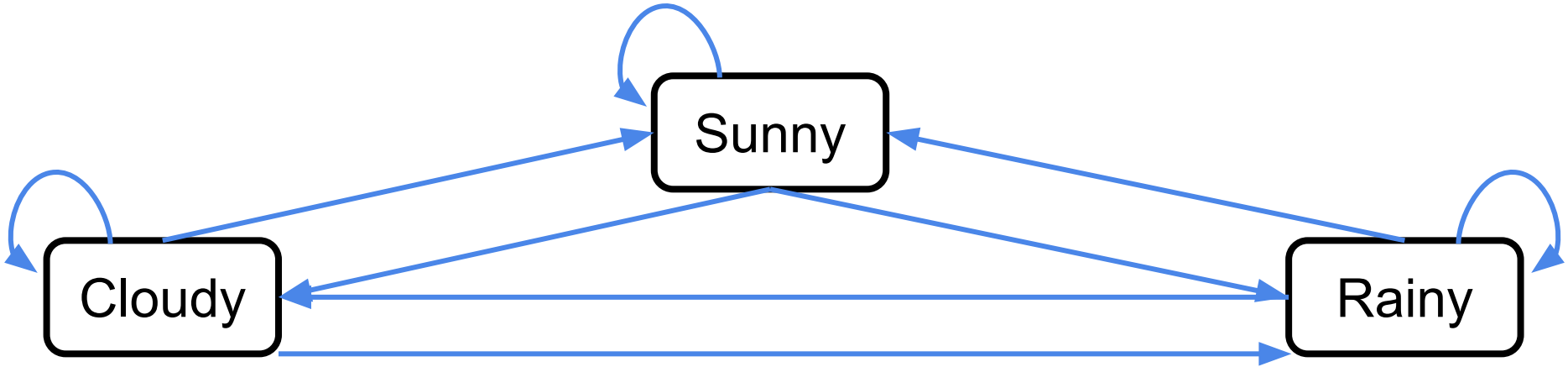

Markov Chains

- **Markov Chains:** A probabilistic model defined by states & transitions
  - In a **first-order** Markov chain, your current state only depends on the state you were in **one step** ago (“memoryless property”)
    - You can also have higher-order (e.g. second, third, etc.) Markov chains, but they will not be discussed in this lecture

Markov Chains to Model Writing

- We can create a Markov chain in which states are words

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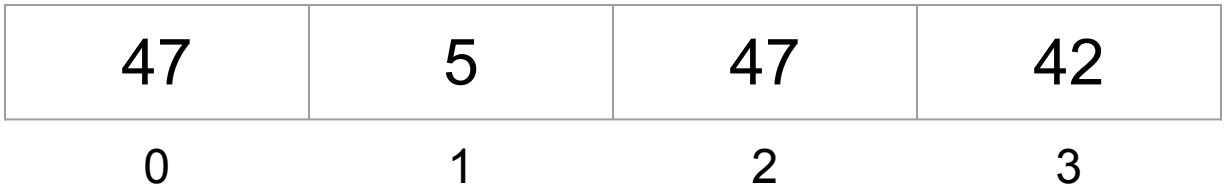
  - How do we end a sentence?

Python Dictionaries

Lists vs. Dictionaries

Lists vs. Dictionaries

- A **list** is a *sequential* container



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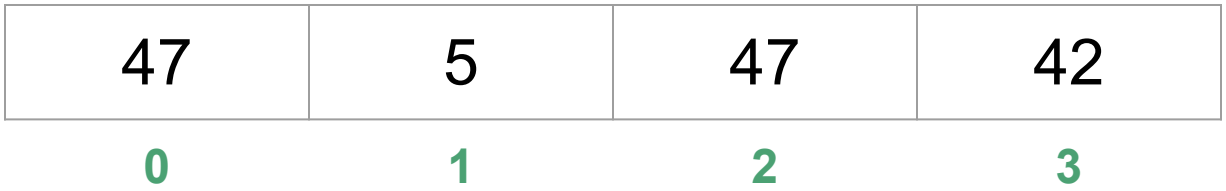

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Lists vs. Dictionaries

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Design a dictionary!

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Practice Problem: Counting Occurrences

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```
counts = dict() # empty dictionary
for word in words:
    if _______________:
        _______________
    else:
        _______________
```

```
# Add the key 'hello'
# and set its value to 0
counts['hello'] = 0

# Get the value associated
# with 'hello'
counts['hello']

# Check if 'hello' is a key
'hello' in counts
```

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```

Files!!

But where will we get so many words??

```
cou
for
        counts[word] = 1
    else:
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```

```
}
```

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- You can use the `read()` function of a file object to read the contents
  - `text = f.read() # text is a string`
- You can use the split() function of a string to split the words apart
  - `words = text.split() # words is a list of strings`

Example: Reading Files in Python

```
f = open('the_hobbit.txt')
text = f.read()
words = text.split()
```

```
In a hole in the ground there lived
a hobbit. Not a nasty, dirty, wet
hole, filled with the ends of worms
and an oozy smell, nor yet a dry,
bare, sandy hole with nothing in it
to sit down on or to eat: it was a
hobbit-hole, and that means comfort.
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the_hobbit.txt

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```

the_hobbit.txt

text

```
"In a hole in the ground..."
```

```
words = ['In', 'a', 'hole',
'in', 'the', 'ground',
'there', 'lived', 'a',
'hobbit.', 'Not', 'a',
'nasty,', 'dirty,', 'wet',
'hole,', ...]
```

Example: Reading Files in Python

How many words are there in total?

d…”

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Example: Reading Files in Python

```
len(words)
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Example: Reading Files in Python

How many unique words are there?

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```

Example: Reading Files in Python

How many unique words are there?

How many instances of each unique word are there?

```
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a h
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Implementing a Markov Model using a Python Dictionary

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  - How will we depict the start of a sentence?

Implementing a Markov Model using a Dictionary

- We will use a Python dictionary to implement a Markov model
  - What are the keys?
  - What are the values?
  - How will we depict the start of a sentence?
    - `None` can be used as “start of sentence” state