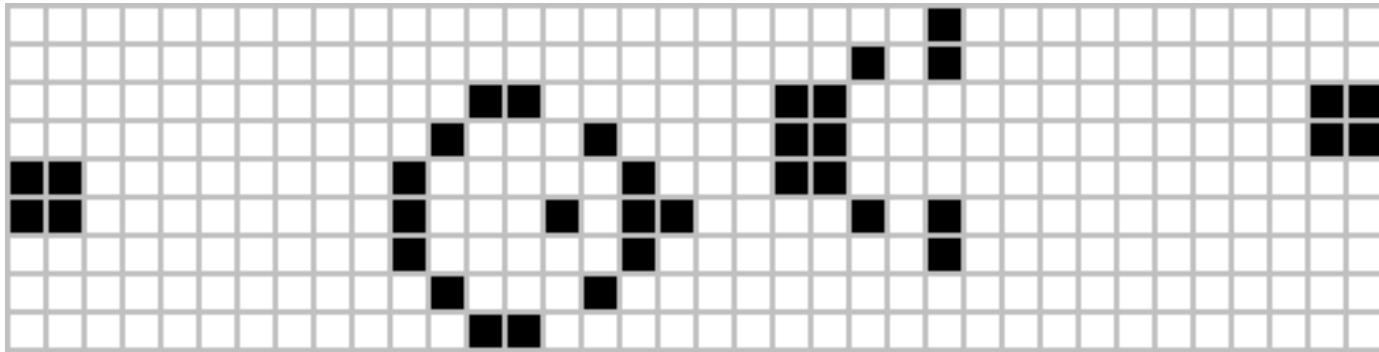


John Conway's Game of Life



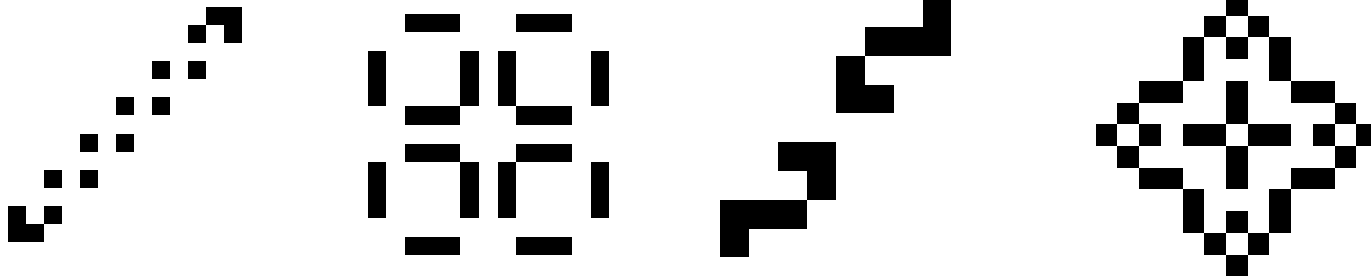
Remember him
from “Look and
Say” sequences?

John Conway



1. Any live cell with fewer than two neighbors dies of loneliness.
2. Any live cell with more than three neighbors dies of overcrowding.
3. Any live cell with two or three neighbors lives, unchanged, to the next generation.
4. Any dead cell with exactly three neighbors comes to life.

John Conway's Game of Life



Oscillators of varying periods

John Conway's Game of Life



Gosper's Glider "Gun"

Life is “Universal” (1982)

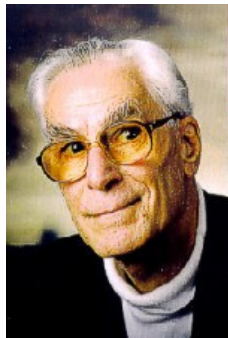
Elwyn Berlekamp



John Conway



Richard Guy



Data Compression

The zzyzva is
known to be a
xenophobic
creature with a
zealous
personality...

TEXT FILE
zzyzva.txt

58,254 bytes

compression
algorithm
(e.g. zip)



B6^9)=\n%%
spam!=&&pe
nguin/?' ,/+

TEXT FILE
zzyzva.txt.Z

23,124 bytes



Now we can
delete the
original file!

Data Compression!

The zzyzva is known to be a xenophobic creature with a zealous personality...

TEXT FILE

| <u>Letter</u> | <u>ord(Letter)</u> | <u>Binary</u> |
|---------------|--------------------|---------------|
| T | 84 | 01010100 |
| h | 104 | 01101000 |
| e | 101 | 01100101 |
| z | 122 | 01111010 |

- “ - 1226754 19.04%
- E - 655257 10.17%
- T - 474521 7.37%
- A - 425718 6.61%
- ... skipping a few ...
- J - 5329 0.08%
- Q - 4923 0.08%
- Z - 3378 0.05%

English text
letter frequencies

But these statistics are on average, not for my essay on the zzyzva!



The Prefix Property

The zzyzva is known to be
a xenophobic creature
with a zealous
personality...

TEXT FILE

| <u>Letter frequency</u> | | <u>Binary code</u> |
|-------------------------|------|--------------------|
| z | 0.25 | 00 |
| y | 0.10 | 01 |
| x | 0.09 | 10 |
| a | 0.08 | 111 |
| r | 0.02 | 1100 |

101110100001100 = 10 111 01 00 00 1100

The Variable Length Coding Problem...

| <u>Letter</u> | <u>Frequency</u> |
|---------------|------------------|
|---------------|------------------|

| | |
|-------|--------------------|
| a_1 | $\text{freq}(a_1)$ |
|-------|--------------------|

| | |
|-------|--------------------|
| a_2 | $\text{freq}(a_2)$ |
|-------|--------------------|

| | |
|-------|--------------------|
| a_3 | $\text{freq}(a_3)$ |
|-------|--------------------|

...

| | |
|-------|--------------------|
| a_n | $\text{freq}(a_n)$ |
|-------|--------------------|

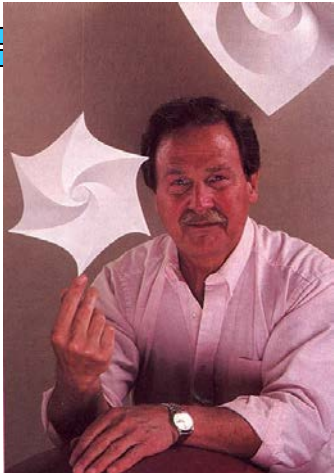


These frequencies
are from the
specific file that
we're planning to
compress!!

Objective: Find a binary prefix code that minimizes...

$$\begin{aligned} &\text{freq}(a_1) \times \text{codelength}(a_1) + \\ &\text{freq}(a_2) \times \text{codelength}(a_2) + \dots \\ &\text{freq}(a_n) \times \text{codelength}(a_n) \end{aligned}$$

The David Huffman Story!



```
map smppam  
ssampamsmam  
...
```

TEXT FILE

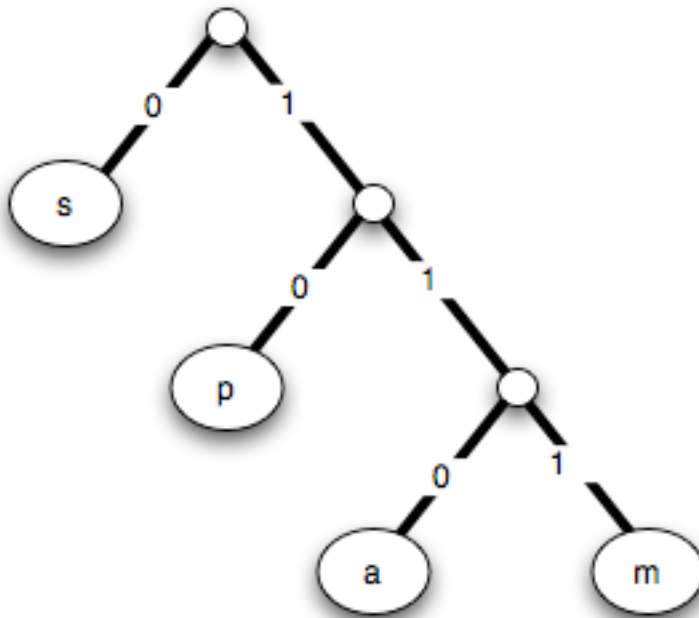
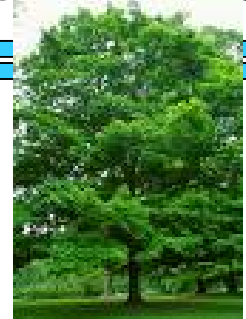
| <u>Letter</u> | <u>freq</u> |
|---------------|-------------|
| s | 0.6 |
| p | 0.2 |
| a | 0.1 |
| m | 0.1 |

ENCODING:

1. Scan text file to compute frequencies
2. Build Huffman Tree
3. Find code for every symbol (letter) - why is this a prefix code?
4. Create new compressed file by saving the entire code at the top of the file followed by the code for each symbol (letter) in the file

I wonder about trees - Robert Frost

We wonder about Robert Frost - Trees



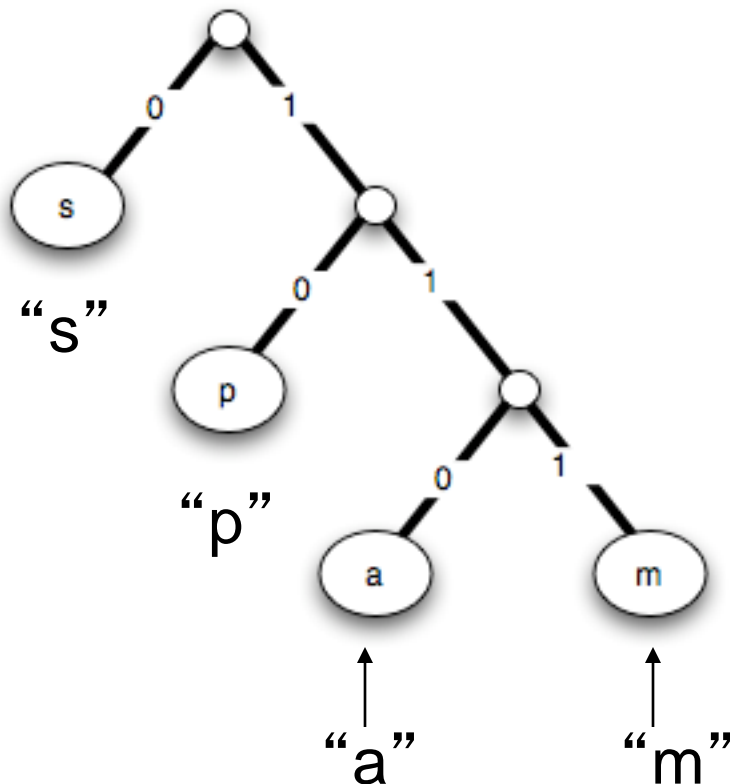
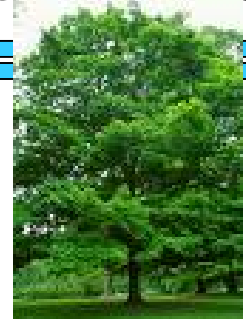
Recursive definition of a tree...

A tree is:

1. Just a symbol (i.e. a “leaf”) or
2. A left subtree and a right subtree

I wonder about trees - Robert Frost

We wonder about Robert Frost - Trees



Recursive definition of a tree...

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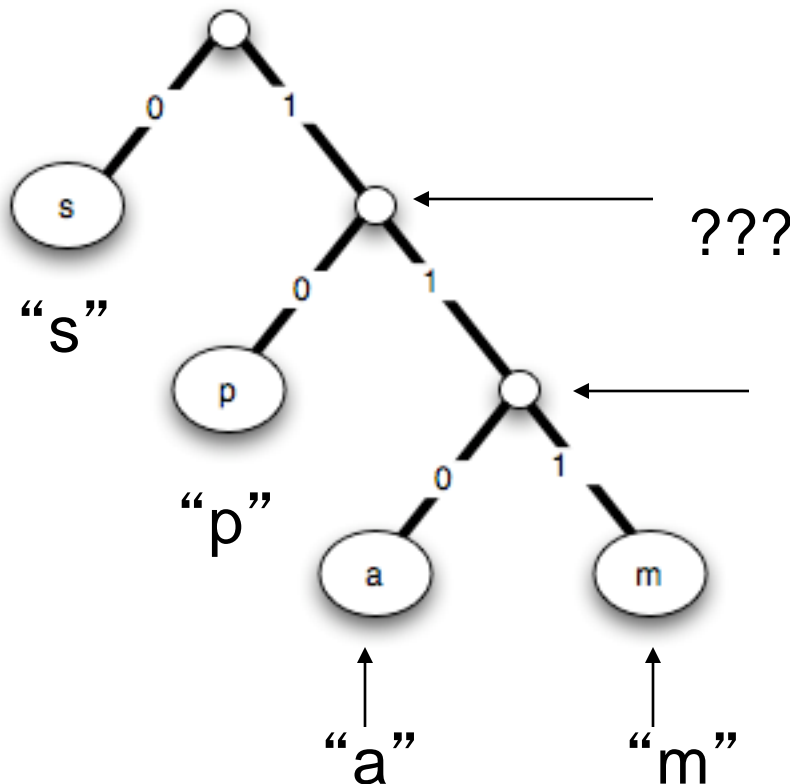
I wonder about trees - Robert Frost

We wonder about Robert Frost - Trees

Recursive definition of a tree...

A tree is:

1. Just a symbol (i.e. a “leaf”) or
2. A left subtree and a right subtree



(“a”, “m”)

Shouldn't that
be the list
[“a”, “m”] ?



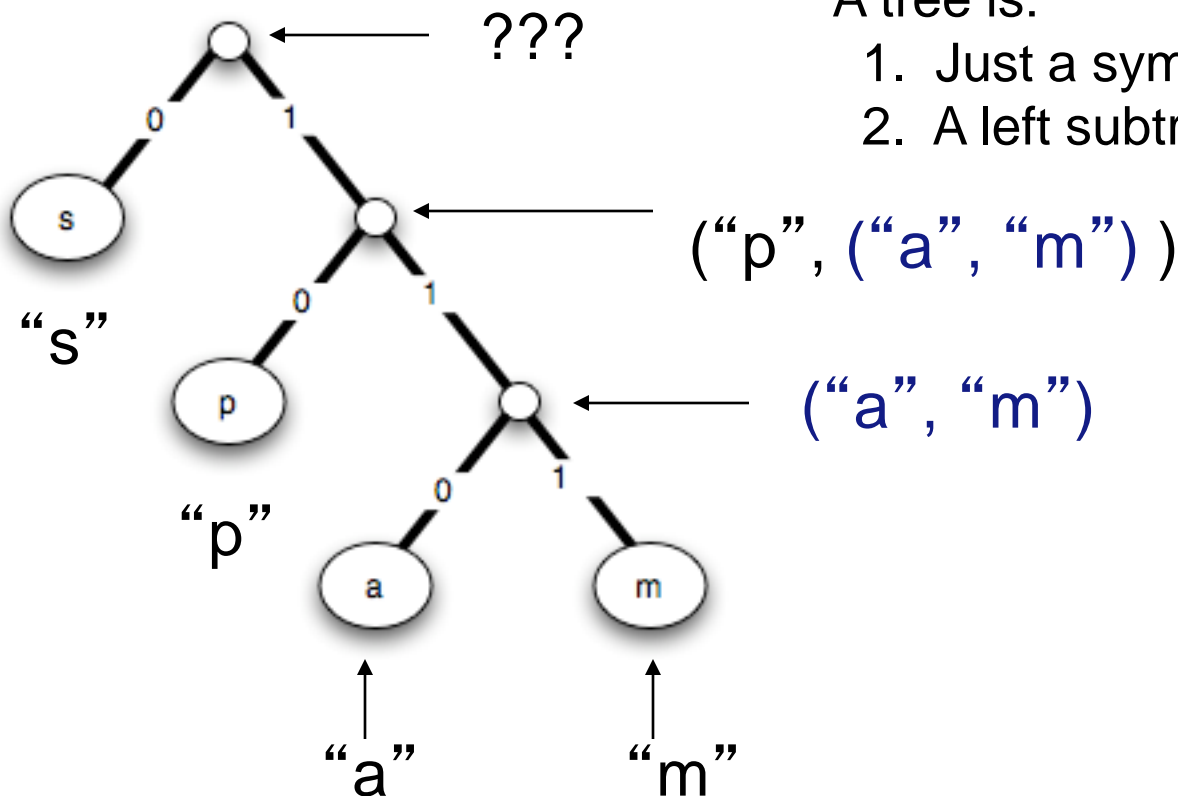
I wonder about trees - Robert Frost

We wonder about Robert Frost - Trees

Recursive definition of a tree...

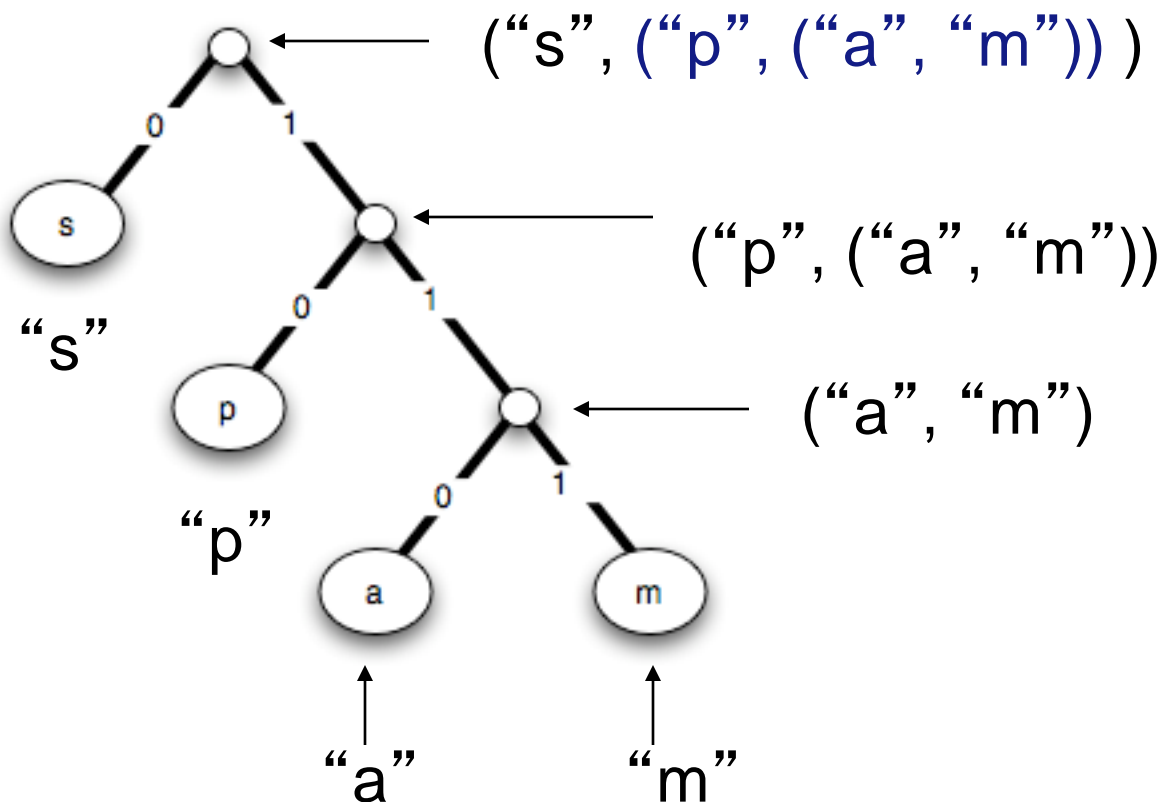
A tree is:

1. Just a symbol (i.e. a “leaf”) or
2. A left subtree and a right subtree



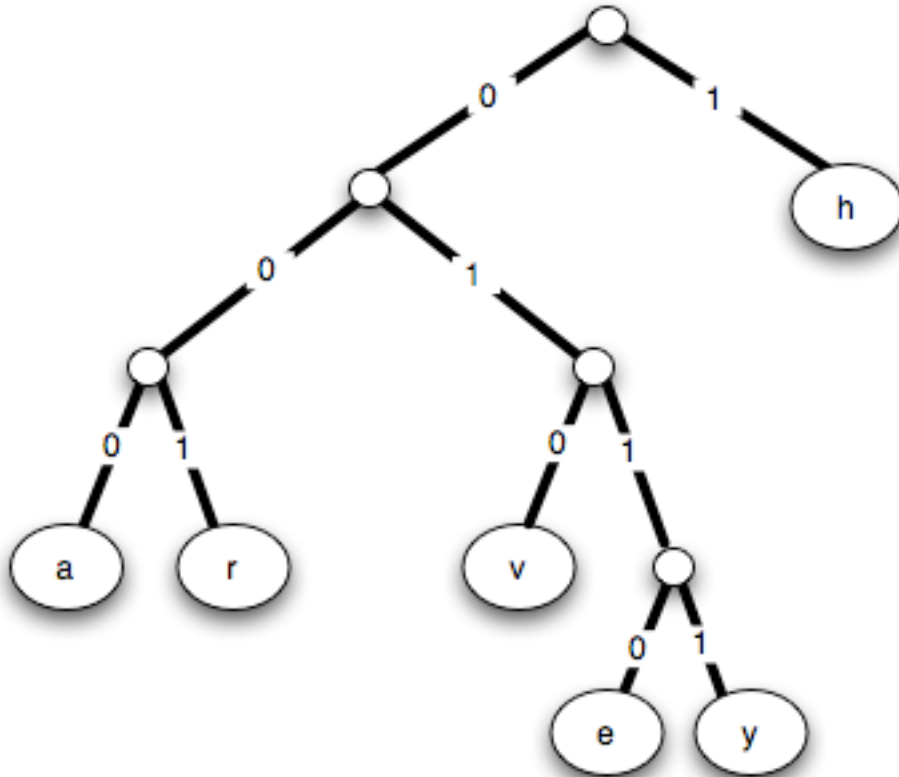
I wonder about trees - Robert Frost

We wonder about Robert Frost - Trees

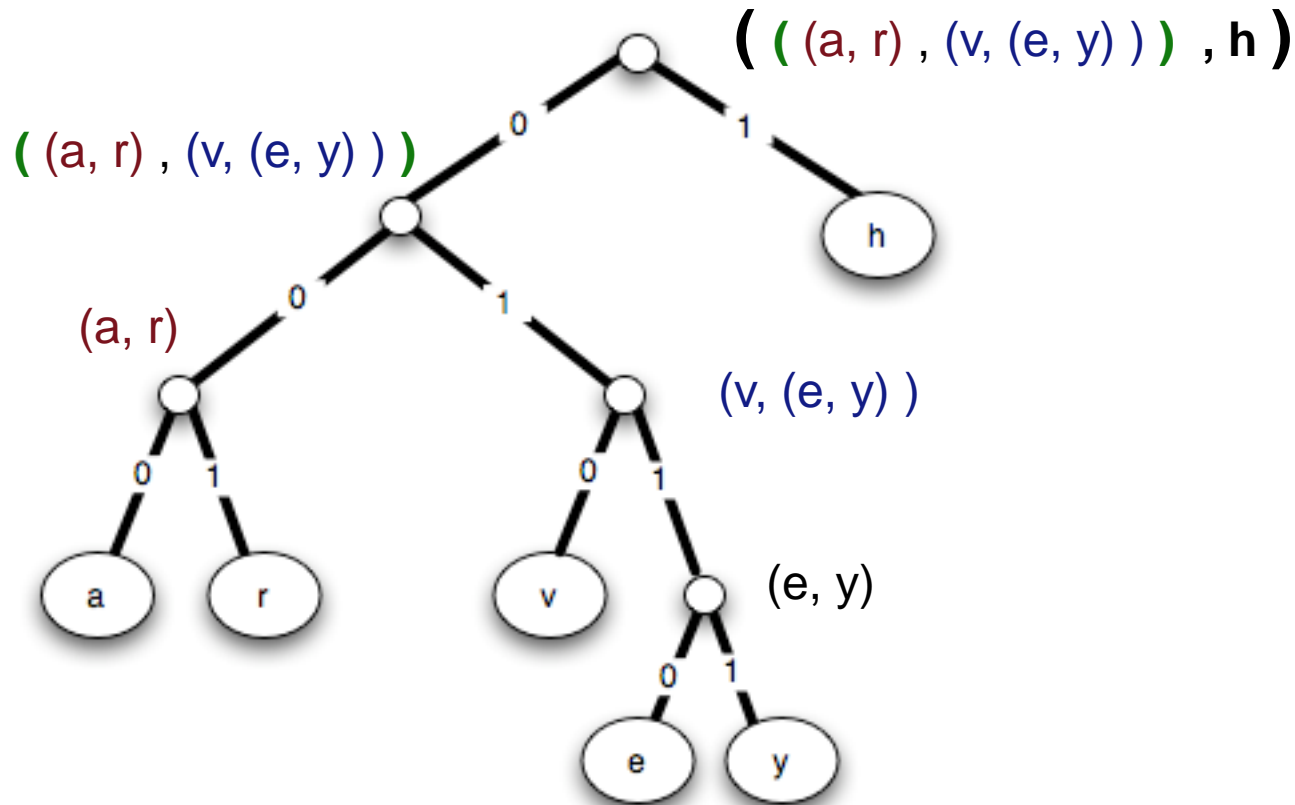


You Try It!

Worksheet



You Try It!



File I/O

```
def read_file():  
    filename = input("Enter the name of a file: ")  
    myfile = open(filename, "r") # "r" means "read"  
    contents = myfile.read()  
    myfile.close()  
    return contents
```

Careful NOT to call this "file"
(file is a built-in name in python)

```
def write_file(string):  
    filename = input("Enter the name of a file: ")  
    myfile = open(filename, "w") # "w" means "write"  
    myfile.write(string)  
    myfile.close()
```

```
write_file("Hello, world!")  
data = read_file()  
print(data)
```



What about line
breaks in the file?