

# Assignment 3 + Compression

## (SNLP Tutorial 4)

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# Assignment 3

- Exercise 1: Entropy Intuition
- Exercise 2: Uncertainty of events
- Exercise 3: KL Divergence
- Bonus: KL Divergence calculation

# Compression

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Prefix codes are a subset of uniquely decodable codes!

## Optimal length of code words

$$l_i = -\log_D p(w_i)$$

# Kraft's Inequality

$$\sum_{i=1}^m D^{-l_i} \leq 1$$

*What does the sum  $< 1$  imply?*

*What does the sum  $= 1$  imply?*

*What does the sum  $> 1$  imply?*

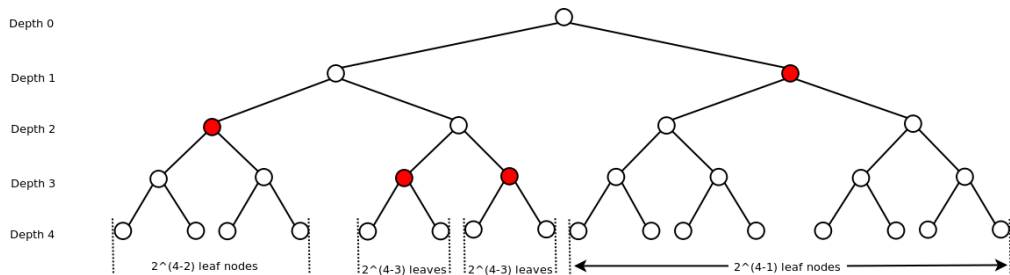
*What does this tell us about uniquely decodable and prefix codes?*

Exercise: Test Kraft's Inequality on Morse Code

(Hint: What is the encoding alphabet?)

# Kraft's Inequality

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Encoding from characters to binary alphabet:

ASCII: 7 bits (byte was standardized to 8 bits later!)

- Q: How many values?
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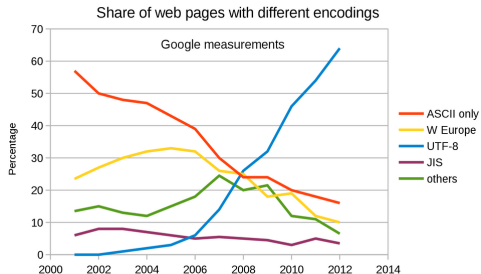
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UTF

- Encoding over Unicode (character alphabet)
- UTF8 - Start with 8 bits, extend to 16 or 32; UTF32 - Always 32 bits
- Compositionality: i with little tail and acute accent U+0301U+0328U+0069
- Valid misuse: snowman U+0301U+0328U+2603

# Encoding - Internet

- Stacks:
  - ▶ OS, browser, HTTP
  - ▶ server (+ frameworks), database (running a different OS)
  - ▶ font rendering, memory order, BOM
  - ▶ etc.



noreply@softconf.com

to zouhar ▾

Dear Vilém Zouhar,

We've written a formatting check tutorial for our new script.



Florenza, Tori <toriflor@amazon.com>

to me ▾

Hello Vilžm,

## Create an IEEE Account

\* Required

\* Given / First name

Vilém

Numbers and special characters are not allowed.

Your submission: [Submission 1 - 7007410 Vil\\_m Zouhar.pdf](#)

# Encoding

## Task

Create encoding (binary) for the following recipe:

apple apple banana cherries apple dark\_chocolate eggplant banana cherries banana ...



# Encoding

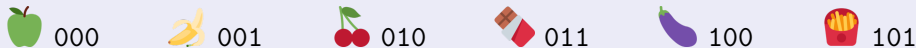
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## Fixed-width encoding









Length =  $14 \times 3 = 42$

## Issues?

- Encoding for  and ?
- What do 110 and 111 mean?

# Encoding - Huffman

4×  A    4×  B    2×  C    2×  E    1×  D    1×  F

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- Can there be two equally good Huffman encodings?
- Can Huffman result in assigning an element code of length 1?

# Long Range Dependencies

- Correlation
- Conditional entropy

# Assignment 4

- Exercise 1: Encodings (ASCII, UTF, Huffman)

```
a = "Hellp there!"
```

```
a[4] = 'o'
```

- Exercise 2: Conditional Entropy on DNA
- Bonus: Huffman Encoding alphabet

# Resources

- 1 Twitter emojis
- 2 <https://www.ics.uci.edu/~dan/pubs/DC-Sec1.html>
- 3 [https://en.wikipedia.org/wiki/Shannon%27s\\_source\\_coding\\_theorem](https://en.wikipedia.org/wiki/Shannon%27s_source_coding_theorem)
- 4 [https://en.wikipedia.org/wiki/Huffman\\_coding](https://en.wikipedia.org/wiki/Huffman_coding)
- 5 <http://www.mss.cbi.fau.de/content/uploads/epnat.pdf>
- 6 <https://arxiv.org/pdf/adap-org/9507007.pdf>
- 7 [https://en.wikipedia.org/wiki/Windows\\_code\\_page](https://en.wikipedia.org/wiki/Windows_code_page)
- 8 <https://r12a.github.io/app-conversion/>
- 9 [https://en.wikipedia.org/wiki/Kraft%E2%80%93McMillan\\_inequality](https://en.wikipedia.org/wiki/Kraft%E2%80%93McMillan_inequality)
- 10 <https://www.freecodecamp.org/news/everything-you-need-to-know-about-encoding/>