

Assignment 3 + Compression

(SNLP Tutorial 4)

Vilém Zouhar, Awantee Deshpande, Julius Steuer

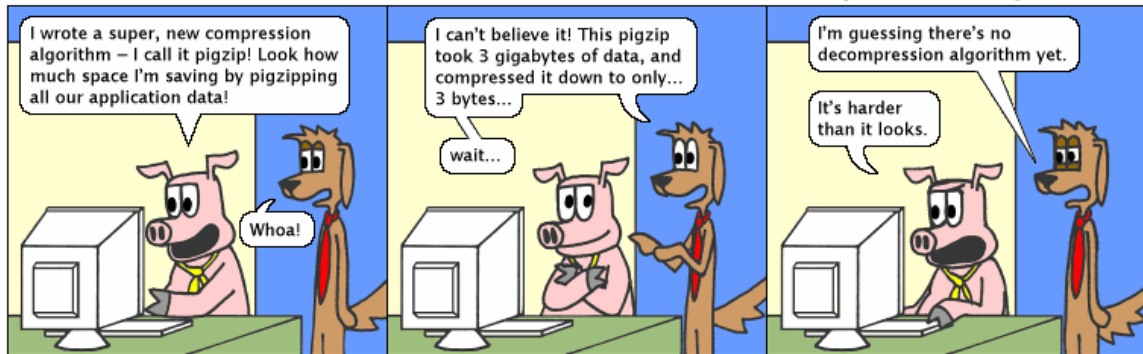
18th, 20th May 2021

Assignment 3

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

Compression

Hackles



<http://hackles.org>

Copyright © 2003 Drake Emko & Jen Brodzik

Compression

- Prefix Codes: No whole code word is a prefix of any other code word
- Uniquely decodable codes: Each word maps to one and only one code word

Compression

- Prefix Codes: No whole code word is a prefix of any other code word
- Uniquely decodable codes: Each word maps to one and only one code word

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?)

Encoding

Task

Create encoding (binary) for the following recipe:

apple apple banana cherries apple dark_chocolate eggplant banana cherries banana ...



Encoding

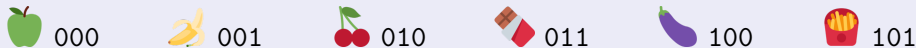
Task

Create encoding (binary) for the following recipe:

apple apple banana cherries apple dark_chocolate eggplant banana cherries banana ...



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

Huffman Bonus

- When will the Huffman tree be balanced?
- How do we store the tree? Does the efficiency of this matter?
- Are there undefined sequences of bits when using Huffman encoding?
- Does the result of Huffman encoding depend on the text ordering?

E.g. 🍏 🍌 🍌 🍫 vs. 🍌 🍫 🍏 🍌

- Can there be two equally good Huffman encodings?

Long Range Dependencies

- Correlation
- Conditional entropy

Assignment 4

- Exercise 1: Encodings (ASCII, UTF, Huffman)
- 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
- 4 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>