Empirical Validation of the Square Root Law of Steganography

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Abstract

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Introduction

- Steganography
- Costs + features
- ? & ? (detectors)

Chapter 2

Hypothesis

- Square root law (point to 2008 paper [1], including graphs)
- List of questions

Chapter 3

Experimental Design

All image sizes discussed are measured in pixels.

3.1 Data

3.1.1 Image Source

The images used in this project were sourced from the Yahoo Flickr Creative Commons 100 Million Dataset (YFCC100M) [2], which contains nearly 100 million images from many users. A user was selected so as to maximize the number of images taken with the same camera, with as many large images of the same size as possible. The user chosen for this project is called "actor 3" and used a Panasonic DMC-TZ3 camera to take 13,349 images. The largest images taken by actor 3 are 3072×2304 and 9539 of the images are of this size. A file called `metadata.txt` for the actor was produced by Dr. Ker when downloading the images. It contains information about the actor (such as camera model) as well as about each image (such as image number, width, and height).

3.1.2 Selection

A script called `initial_curation.py` was written to select the largest images and put them in a standard format. The script uses the metadata file to identify the images that are 3072×2304, makes all of these images grayscale, rotates the portrait ones to landscape, and places the resulting images in a new directory. The script took around 10 minutes to run and 9539 grayscale, 3072×2304, landscape images were produced.

3.1.3 Selecting Image Sizes

The primary goal of the experiments is to produce a graph plotting the image size in pixels against a classifier's accuracy. This involves running experiments on images of several different sizes, which will be produced by cropping the 9539 images of size 3072×2304. To best display the trends in the experiment results, ten image sizes had to be selected in such a way that the total numbers of pixels

The largest size is 3072×2304 since that is the largest size we have from `actor00003` and the smallest size was somewhat arbitrarily chosen to be 360×240. In the graphs with my experiment results, I will want the image sizes (specifically the total number of pixels) to be evenly distributed along the x-axis. In order to achieve this, I picked sizes such that the difference between the number of pixels in consecutive image sizes is roughly the same. I calculated this interval using:

$$\frac{3072 \cdot 2304 - 320 \cdot 240}{9} \approx 777,899 \text{ pixels}$$

It is straightforward to compute the total number of pixels in the n^{th} image size (where 320×240 is the 1^{st} size and 3072×2304 is the 10^{th} size):

$$320 \cdot 240 + (n-1) \cdot 777,899$$

Given the desired number of pixels (call it P), we can find dimensions with a 4:3 ratio that produce approximately P pixels. We do so by solving the following equation for x and then computing $4x$ and $3x$ to get the dimensions:

$$P \approx 4x \cdot 3x = 12x^2$$

The results of these computations are:

Width	Height	Total pixels
3072	2304	7,077,888
2912	2184	6,359,808
2720	2040	5,548,800
2528	1896	4,793,088
2304	1728	3,981,312
2048	1536	3,145,728
1792	1344	2,408,448
1472	1104	1,625,088
1056	792	836,352
320	240	76,800

3.2 Embedding

3.3 Features

3.4 Costs

Chapter 4

Results & Analysis

- Tables & pictures

Chapter 5

Conclusion

Bibliography

[1] A. D. Ker, T. Pevný, J. Kodovský, and J. Fridrich. The square root law of steganographic capacity. In *Proceedings of the 10th ACM Workshop on Multimedia and Security*, MM&Sec '08, pages 107–116, New York, NY, USA, 2008. ACM.

[2] B. Thomee, B. Elizalde, D. Shamma, K. Ni, G. Friedland, D. Poland, D. Borth, and L.-J. Li. YFCC100M: the new data in multimedia research. *Communications of the ACM*, 59:64–73, January 2016.