Mr. Tucker, Meet Mr. Shakespeare

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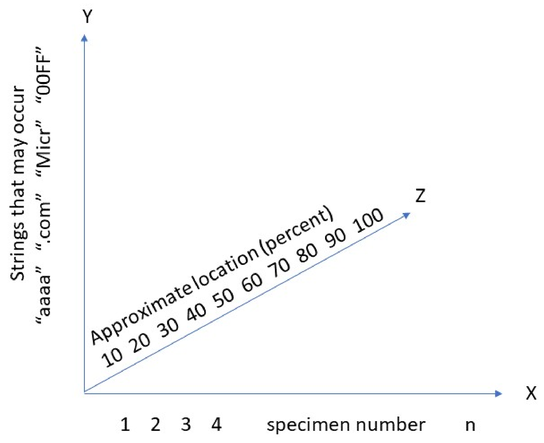
Objectives

To investigate the use of tensor decomposition in static malware analysis - on a large scale

- Malware analysis is often done, and taught, "in the small", that is, on one specimen at time [1]
- We need ways to do malware analysis "in the large"
- Malware specimens, in the form of executable binaries for the Windows platform, are abundant. Can we use tensor decomposition to gain insight into large collections of malware? We selected a specific malware family, the well-known Zeus Trojans [2], as test subjects.

Introduction

There are many ways to build a tensor for such objects, but we chose something simple: tabulate the occurrence of specific 4-grams (of which there are *many*) in a 3-d array, with X being the specimen ID, y being a 4-gram that may or may not occur in a given specimen, and z being that 4-gram's relative position within the specimen. So in the 3-d array shown below, entry $x_{i,j,k}$ is how many times 4-gram j occurs, in decile k, of specimen i.



Tucker Decomposition [3]

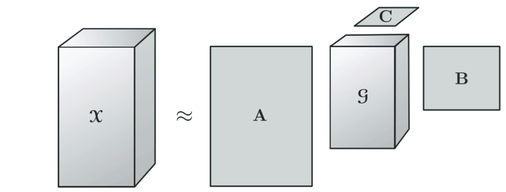
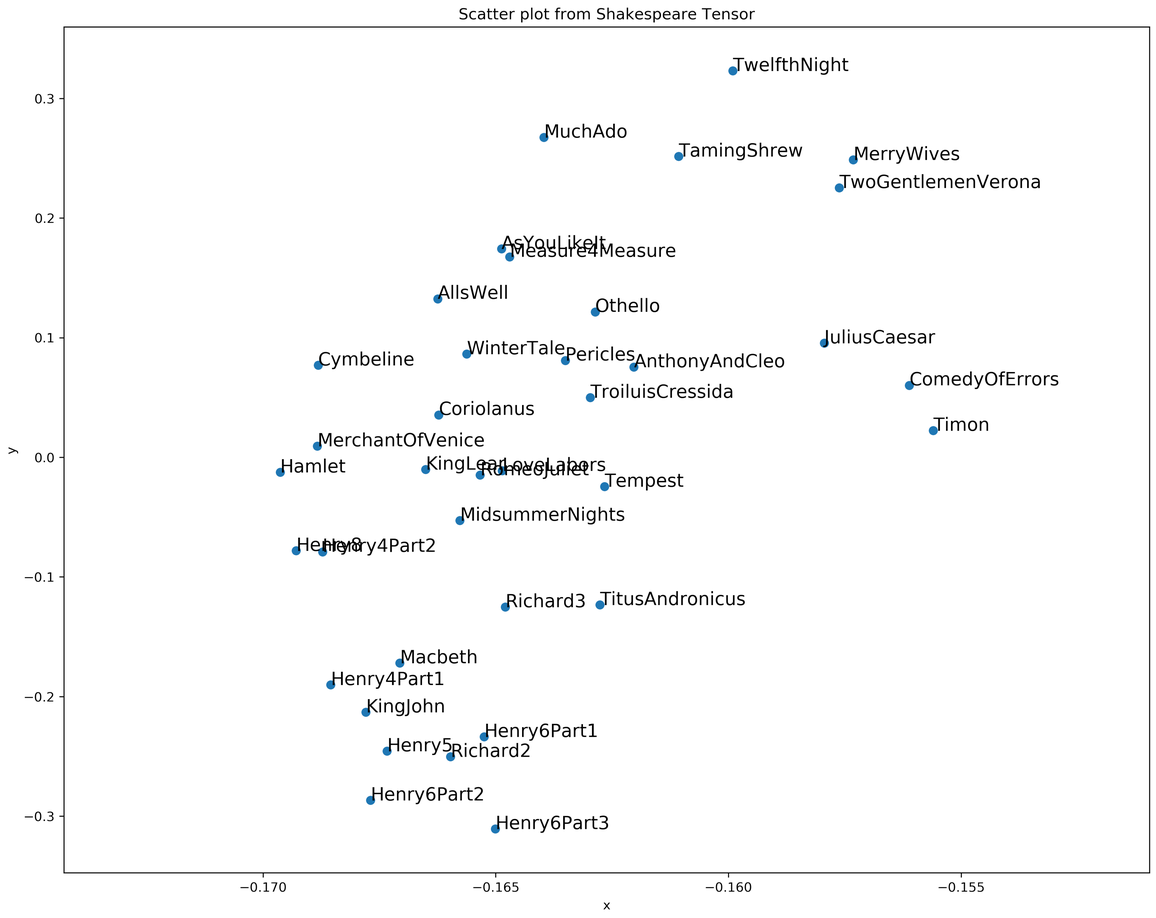


Fig. 4.1 *Tucker decomposition of a three-way array.*

The Matrix A from Tucker Decomposition



Sanity Check - Shakespeare

Before jumping into the Zeus data, we wanted to try it with a smaller corpus - the Shakespearean plays. [4] Using Python packages `tensorflow` (to do the tensor calculations) and `sklearn` (to parse the text data), in a Jupyter Notebook, we built the tensor X and ran both HOSVD and HOOI versions of Tucker.

Observations

- In the Shakespearean tensor X, entry $x_{i,j,k}$ is the number of times word j occurs in Act k of play i. The value of i ranges from 1 to 37, j ranges from 1 to about 30,000, and k ranges from 1 to 5. The tensor is quite sparse.
- HOSVC and HOOI gave similar results
- Pleased with the unsupervised clustering, especially of the history plays.

Research Continues

- Malware binaries will have *many* more terms, so we need to be selective.
- Only some of the Zeus binaries are unpacked, but focus on those first.

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