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Pattern Discovery of Sequential Symbolic Data using Automata with an application to Author Identification

Nikhil Kalantri
San Jose State University

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Pattern Discovery of Sequential Symbolic Data using Automata with an application to Author Identification

A Thesis
Presented to
The Faculty of the Department of Computer Science
San José State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Nikhil Kalantri
December 2013

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SAN JOSE STATE UNIVERSITY

The Designated Thesis Committee Approves the Thesis Titled

Pattern Discovery of Sequential Symbolic Data using Automata with an application to Author Identification

by

Nikhil Kalantri

APPROVED FOR THE DEPARTMENT OF COMPUTER SCIENCE

SAN JOSÉ STATE UNIVERSITY

December 2013

Dr. T. Y. Lin, Department of Computer Science

Date

Dr. Chris Tseng, Department of Computer Science

Date

Mr. Amit Sant, Software Engineer at Apple

Date

ABSTRACT

Author Identification is the process of identifying a piece of text to ascertain if it has an inherent writing style or pattern based on a certain author. Almost all literary books can be accredited to a certain author since it has been signed. However, there also exist a plethora of unfinished books or manuscripts that could be attributed to a range of possible authors. For example, William Shakespeare has written many plays that have not been signed by him. In order to assess the importance of such texts that do not bear the authors signature, it could be vital to know who was the writer. I plan to solve this dilemma using the characteristics of finite state automata coupled with the ALERGIA algorithm.

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1. Introduction

1.1. What is author identification?

It is the process of identifying the creator of a written text through computational, statistical analysis. This analysis assists in capturing an author's inherent writing style and this pattern can be used to find the source of an unsigned document.

1.2. Why do we need author identification?

Author identification is an important problem in many areas ranging from information retrieval and computational linguistics to journalism and law where this could potentially help in saving lives like discover the author of a ransom note.

1.3. Why use computational/statistical methods?

Every author has a unique style of writing just like a human fingerprint. The human eye cannot recognize or pick up all the varying aspects of a document. Computational methods allow and aid humans to improve pattern analysis by exploring and uncovering these hidden traits of documents. A famous example to identify authors was shown by Professor Arthur Kinney in 2006. He proves that all unsigned Shakespeare documents or plays that were attributed to him, were indeed his with the help of statistical analysis.

1.4. Attributes of a document

Attributes are divided into four broad categories – Lexical, syntactic, structural and content-specific. These attributes help differentiate between authors. A few examples for each of the attributes are given below.

- Lexical: average number of words in a sentence, length of the word, total words.
- Syntactic: punctuations.
- Structural: font types, headers, footers, paragraph style.
- Content-specific: Number of stop words or abbreviations, gender or age based words.

1.5. Role of automata theory

The objective of this paper is to analyze sample texts based on automata [5][12] theory. This is achieved by generating a prefix tree acceptor by filtering out the stop words in a book and then applying the Alergia algorithm to check the compatibility of corresponding states. The algorithm regenerates the PTA iteratively through merging all compatible or equivalent states.

2. Finite State Automata

2.1. Deterministic Finite Automaton

Definition: A deterministic finite automaton consists of the following parameters:

- A finite set of states denoted by Q
- A finite set of symbols Σ
- A transition function that takes a state and a symbol as arguments and returns a state. It is denoted by δ .
- The start state denoted by q_0
- Set of final or accepting states denoted by F

Therefore, we have $q_0 \in Q$ and $F \subseteq Q$.

So a DFA is mathematically represented as a 5-uple $(Q, \Sigma, \delta, q_0, F)$.

The transition function δ is a function in

$$Q \times \Sigma \rightarrow Q$$

$Q \times \Sigma$ is the set of 2-tuples (q, a) with $q \in Q$ and $a \in \Sigma$

A DFA with a transition table is given as

	0	1
$\rightarrow q_0$	q_2	q_0
$*q_1$	q_1	q_1
q_2	q_2	q_1

Figure 1: State transition table

This transition table defines the following transition diagram,

Figure 2: State Transition Diagram

Therefore,

$$Q = \{q_0, q_1, q_2\}$$

Start state q_0

$$F = \{q_1\}$$

$$\Sigma = \{0, 1\}$$

δ is a function from $Q \times \Sigma$ to Q

$$\delta: Q \times \Sigma \rightarrow Q$$

$$\delta(q_0, 1) = q_0$$

$$\delta(q_0, 0) = q_2$$

2.2. Stochastic Finite State Automata

A stochastic finite state automaton [9] provides transition probabilities to each of the next states in addition to providing the finite state automata [5][12] for the given input.

For example, consider input symbols b_1, b_2 . Now, there is a possibility of two arbitrary transitions $\delta(q, b_1)$ or $\delta(q, b_2)$. SFA helps us in analyzing and evaluating the probability of a transition to each of the states.

The probability function to calculate arbitrary transitions is given by,

$$p_{if} + \sum_{q_j \in Q} \sum_{a \in A} p_{ij}(a) = 1$$

This shows that the sum of probabilities that start and end at node q_i is always equal to 1.

The language generated by stochastic finite automata [9] is known as stochastic regular language (SRL).

3. ALERGIA Algorithm

The Alergia algorithm specializes in merging the states of a generated automaton from a probabilistic point of view. Alergia is a learning algorithm. Consider a sample set containing duplicate strings; the algorithm can learn its Deterministic Frequency Finite Automata [5] and also the Deterministic Probabilistic Finite Automata [5].

When the probability of appearance of a string follows a well-defined distribution, Alergia has the ability to take advantage of this and merge states when the resulting automaton is compatible with the observed frequency of strings.

First the algorithm generates a prefix tree from the input strings and analyzes the relative frequency of outgoing arcs at every node. The prefix tree captures this information.

Let n_i be the number of strings arriving at node q_i .

$f_i(a)$: Number of strings following arc $\delta_i(a)$

$f_i(\#)$: Number of strings terminating at node q_i

Calculate the following probabilities:

$$p_i(a) = f_i(a)/n_i$$

$$p_{if} = f_i(\#)/n_i$$

The algorithm compares corresponding nodes (q_i, q_j). The value of j varies from 2 to t and i varies from 1 to $j-1$.

When the probabilities of two corresponding states are equal, they are considered equivalent and this rule applies to their corresponding children.

If the difference between the probabilities of the two states is less than the acceptance range α , these states are considered as compatible. Recursively, the child nodes are also considered compatible.

A false value will be returned if the probability difference is greater than the acceptance rate. The formula to compare two states is given by the Hoeffding bound:

$$\left| \frac{f}{n} - \frac{f'}{n'} \right| < \sqrt{\frac{1}{2} \log \frac{2}{\alpha} \left(\frac{1}{\sqrt{n}} + \frac{1}{\sqrt{n'}} \right)}$$

There are 3 algorithms that we consider:

Algorithm **COMPATIBLE**

Input:

i, j : nodes

Output:

Boolean

Begin

If different ($n_i, f_i(\#), n_j, f_j(\#)$)

Return false

Endif

Do ($\forall a \in A$)

If different ($n_i, f_i(a), n_j, f_j(a)$)

Return false

End if

If not compatible ($\delta(i,a), \delta(j,a)$)

Return false

End if

End do

Return true

End algorithm

Algorithm **DIFFERENT**

Input:

n, n' : number of strings arriving at each node.

f, f' : number of strings ending or following a given arc

Output:

Boolean

Begin

Return $\left| \frac{f}{n} - \frac{f'}{n'} \right| < \sqrt{\frac{1}{2} \log \frac{2}{\alpha} \left(\frac{1}{\sqrt{n}} + \frac{1}{\sqrt{n'}} \right)}$

End Algorithm

Algorithm **ALERGIA**

Input:

S : sample set of strings

α : 1-confidence level

Output:

Stochastic DFA

Begin

A = stochastic Prefix Tree Acceptor from S

Do (for j = successor (first node (A)) to last node (A))

Do (for i = first node (A) to j)

If compatible (i, j)

Merge (A, i, j)

Determinize (A)

Exit (i -loop)

End if

End for

End for

Return A

End algorithm

4. Analyzing text using automata based modeling

Consider an input string,

$S = \{110, -, -, 0, -, -, 00, -, -, 100, -, -, 10110\}$

Let $\alpha = 0.8$

Step 1: Build the Prefix Tree Acceptor tree

Therefore, $\Upsilon = \sqrt{\frac{1}{2} \log \frac{2}{\alpha}} \approx 0.67$

Every arc for each transition has a label with 0 or 1 and the number of strings in the input using that arc is shown in brackets. Then the algorithm checks for the equivalence of corresponding nodes. This is achieved by comparing their SFA probabilities.

Figure 3: PTA tree for sample string S [9]

Step 2: Minimize the states using the Hoeffding bound.

We generate the Deterministic Frequency Finite Automaton by applying the algorithm to merge compatible nodes. After merging thrice with $\alpha = 0.8$, we get

Figure 4: PTA after merging q_2 and q_1 [9]

Figure 5: PTA after merging q_5 and q_1 [9]

Figure 6: PTA after merging q_6 and q_3 [9]

5. Test Results

Test case ID: 01

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling – HP0.txt

Test books:

- JK Rowling – HP0.txt
- JK Rowling – HP1.txt
- James Matthew Barrie - Peter Pan.txt

Test Output:

Testing Doc01: 1 JK Rowling – HP0.txt

Testing Doc02: 2 JK Rowling – HP1.txt

Testing Doc03: 3 James Matthew Barrie – Peter Pan.txt

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)
1	0.10	99.981	96.949	89.933
2	0.20	99.979	97.816	87.154
3	0.30	99.978	91.365	81.706
4	0.40	99.975	88.721	74.585
5	0.50	99.972	82.808	71.283
6	0.60	99.971	79.368	67.767
7	0.70	99.965	77.896	53.931
8	0.80	99.962	71.540	35.822
9	0.90	99.955	69.571	33.446
10	1.00	99.951	68.831	29.595

Table 1: Result for test case ID: 01

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 02

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling – HP0.txt

Test books:

- JK Rowling – HP0.txt
- JK Rowling – HP1.txt
- Dante Alighieri - The Divine Comedy.txt

Test Output:

Testing Doc01: 1 JK Rowling - HP0.txt

Testing Doc02: 2 JK Rowling - HP1.txt

Testing Doc03: 3 Dante Alighieri - The Divine Comedy.txt

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)
1	0.10	99.981	96.949	69.223
2	0.20	99.979	97.816	67.544
3	0.30	99.978	91.365	61.876
4	0.40	99.975	88.721	54.295
5	0.50	99.972	82.808	52.813
6	0.60	99.971	79.368	47.007
7	0.70	99.965	77.896	43.971
8	0.80	99.962	71.540	35.881
9	0.90	99.955	69.571	33.401
10	1.00	99.951	68.831	30.513

Table 2: Result for test case ID: 02

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 03

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling – HP0.txt

Test books:

- JK Rowling – HP0.txt
- JK Rowling – HP1.txt
- Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt

Test Output:

Testing Doc01: 1 JK Rowling – HP0.txt

Testing Doc02: 2 JK Rowling – HP1.txt

Testing Doc03: 3 Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)
1	0.10	99.981	96.949	59.282
2	0.20	99.979	97.816	55.509
3	0.30	99.978	91.365	51.869
4	0.40	99.975	88.721	44.239
5	0.50	99.972	82.808	42.887
6	0.60	99.971	79.368	37.012
7	0.70	99.965	77.896	33.996
8	0.80	99.962	71.540	25.827
9	0.90	99.955	69.571	23.472
10	1.00	99.951	68.831	21.273

Table 3: Result for test case ID: 03

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 04

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling – HP0.txt

Test books:

- JK Rowling – HP0.txt
- JK Rowling – HP1.txt
- Edgar Rice Burroughs - A Princess of Mars.txt

Test Output:

```
Testing Doc01: 1 JK Rowling - HP0.txt
Testing Doc02: 2 JK Rowling - HP1.txt
Testing Doc03: 3 Edgar Rice Burroughs - A Princess of Mars.txt
-----
i  Alpha Doc01(%) Doc02(%) Doc03(%)
--  ----
1  0.10  99.981   96.949   74.361
2  0.20  99.979   97.816   71.467
3  0.30  99.978   91.365   68.891
4  0.40  99.975   88.721   64.412
5  0.50  99.972   82.808   63.782
6  0.60  99.971   79.368   57.561
7  0.70  99.965   77.896   56.781
8  0.80  99.962   71.540   45.771
9  0.90  99.955   69.571   42.631
10 1.00  99.951   68.831   41.622
-----
```

Table 4: Result for test case ID: 04

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 05

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Paulo Coelho – The Alchemist.txt

Test books:

- Paulo Coelho – The Alchemist.txt
- Paulo Coelho - The Zahir.txt
- James Joyce - Dubliners.txt

Test Output:

```
Testing Doc01: 1 Paulo Coelho - The Alchemist
Testing Doc02: 2 Paulo Coelho - The Zahir.txt
Testing Doc03: 3 James Joyce - Dubliners.txt
```

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)
1	0.10	99.981	99.949	89.933
2	0.20	99.979	97.816	87.154
3	0.30	99.978	91.365	81.706
4	0.40	99.975	88.721	74.585
5	0.50	99.972	82.808	70.633
6	0.60	99.971	79.368	63.707
7	0.70	99.965	77.896	52.961
8	0.80	99.962	77.540	51.822
9	0.90	99.955	75.371	49.666
10	1.00	99.951	73.731	44.595

Table 5: Result for test case ID: 05

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Paulo Coelho have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 06

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Friedrich Nietzsche - Beyond Good and Evil.txt

Test books:

- Friedrich Nietzsche - Beyond Good and Evil.txt
- Friedrich Nietzsche – The Antichrist.txt
- Dante Alighieri - The Divine Comedy.txt

Test Output:

Testing Doc01: 1 Friedrich Nietzsche - Beyond Good and Evil.txt

Testing Doc02: 2 Friedrich Nietzsche - The Antichrist.txt

Testing Doc03: 3 Dante Alighieri - The Divine Comedy.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)
1	0.10	99.981	99.949	89.933
2	0.20	99.979	97.816	87.154
3	0.30	99.978	91.365	81.706
4	0.40	99.975	88.721	74.585
5	0.50	99.972	82.808	70.633
6	0.60	99.971	79.368	63.707
7	0.70	99.965	77.896	52.961
8	0.80	99.962	71.540	35.822
9	0.90	99.955	69.571	29.666
10	1.00	99.927	68.831	27.595

Table 6: Result for test case ID: 06

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Friedrich Nietzsche have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 07

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Bram Stoker – Dracula.txt

Test books:

- Bram Stoker – Dracula.txt
- Bram Stoker – The Primrose Path.txt
- Bram Stoker – The Mystery of the Sea.txt

Test Output:

```
Testing Doc01: 1 Bram Stoker - Dracula.txt
Testing Doc02: 2 Bram Stoker - The Primrose Path.txt
Testing Doc03: 3 Bram Stoker - The Mystery of the Sea.txt
```

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)
1	0.10	99.986	99.749	99.913
2	0.20	99.977	97.636	97.174
3	0.30	99.975	91.455	91.716
4	0.40	99.972	88.421	89.595
5	0.50	99.971	83.865	85.663
6	0.60	99.970	78.356	83.737
7	0.70	99.967	75.833	79.911
8	0.80	99.963	74.522	75.822
9	0.90	99.959	71.534	74.654
10	1.00	99.954	69.451	71.593

Table 7: Result for test case ID: 07

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that all the books have a high matching percentage since all of them have been written by Bram Stoker.

Pass/Fail: The test has passed.

Test case ID: 08

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Charles Dickens - David Copperfield.txt

Test books:

- Charles Dickens - David Copperfield.txt
- Charles Dickens - A Christmas Carol.txt
- Bram Stoker - The Mystery of the Sea.txt
- Bram Stoker - Under the Sunset.txt

Test Output:

```
Testing Doc01: 1 Charles Dickens - David Copperfield.txt
Testing Doc02: 2 Charles Dickens - A Christmas Carol.txt
Testing Doc03: 3 Bram Stoker - The Mystery of the Sea.txt
Testing Doc04: 4 Bram Stoker - Under the Sunset.txt
```

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)
1	0.10	99.986	99.756	89.913	86.237
2	0.20	99.977	97.676	77.174	77.434
3	0.30	99.975	91.423	71.716	73.145
4	0.40	99.972	88.453	69.595	71.957
5	0.50	99.971	83.892	55.663	66.387
6	0.60	99.970	77.379	43.737	58.712
7	0.70	99.967	73.819	39.911	47.998
8	0.80	99.963	70.592	35.822	45.393
9	0.90	99.959	67.567	34.654	41.726
10	1.00	99.954	63.493	31.593	40.571

Table 8: Result for test case ID: 08

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Charles Dickens have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 09

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Friedrich Nietzsche - Beyond Good and Evil.txt

Test books:

- Friedrich Nietzsche - Beyond Good and Evil.txt
- Friedrich Nietzsche – The Antichrist.txt
- Dante Alighieri - The Divine Comedy.txt
- James Matthew Barrie - Peter Pan.txt
- Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt

Test Output:

Testing Doc01: 1 Friedrich Nietzsche - Beyond Good and Evil.txt
Testing Doc02: 2 Friedrich Nietzsche - The Antichrist.txt
Testing Doc03: 3 Dante Alighieri - The Divine Comedy.txt
Testing Doc04: 4 James Matthew Barrie - Peter Pan.txt
Testing Doc05: 5 Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)
1	0.10	99.981	99.949	89.933	69.917	72.612
2	0.20	99.979	97.816	87.154	67.482	66.123
3	0.30	99.978	91.365	81.706	63.123	55.456
4	0.40	99.975	88.721	74.585	61.981	48.989
5	0.50	99.972	82.808	70.633	56.363	39.933
6	0.60	99.971	79.368	63.707	48.701	32.393
7	0.70	99.965	77.896	52.961	39.924	29.807
8	0.80	99.962	71.540	35.822	35.390	21.402
9	0.90	99.955	69.571	29.666	34.799	18.198
10	1.00	99.927	68.831	27.595	31.522	13.327

Table 9: Result for test case ID: 09

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Friedrich Nietzsche have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 10

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling – HP0.txt

Test books:

- JK Rowling – HP0.txt
- JK Rowling – HP1.txt
- Dante Alighieri - The Divine Comedy.txt
- James Matthew Barrie - Peter Pan.txt
- Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt

Test Output:

```
Testing Doc01: 1 JK Rowling - HP0.txt
Testing Doc02: 2 JK Rowling - HP1.txt
Testing Doc03: 3 Dante Alighieri - The Divine Comedy.txt
Testing Doc04: 4 James Matthew Barrie - Peter Pan.txt
Testing Doc05: 5 Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt
```

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)	Doc04 (%)	Doc05 (%)
1	0.10	99.981	99.949	89.933	69.917	72.612
2	0.20	99.979	97.816	87.154	67.482	66.123
3	0.30	99.978	91.365	81.706	63.123	55.456
4	0.40	99.975	88.721	74.585	61.981	48.989
5	0.50	99.972	82.808	70.633	56.363	39.933
6	0.60	99.971	79.368	63.707	48.701	32.393
7	0.70	99.965	77.896	52.961	39.924	29.807
8	0.80	99.962	71.540	35.822	35.390	21.402
9	0.90	99.955	69.571	29.666	34.799	18.198
10	1.00	99.927	78.831	37.595	31.522	13.327

Table 10: Result for test case ID: 10

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 11

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Bram Stoker – Dracula.txt

Test books:

- Bram Stoker – Dracula.txt
- Bram Stoker - The Mystery of the Sea.txt
- Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt
- Edgar Rice Burroughs - A Princess of Mars.txt
- Elliott Whitney - The Pirate Shark.txt
- Frank Baum - The Wonderful Wizard of Oz.txt
- Friedrich Nietzsche - Beyond Good and Evil.txt
- Harrison Williams - Legends of Loudoun.txt

Test Output:

Testing Doc01: 1 Bram Stoker – Dracula.txt
Testing Doc02: 2 Bram Stoker – The Mystery of the Sea.txt
Testing Doc03: 3 Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt
Testing Doc04: 4 Edgar Rice Burroughs – A Princess of Mars.txt
Testing Doc05: 5 Elliott Whitney – The Pirate Shark.txt
Testing Doc06: 6 Frank Baum – The Wonderful Wizard of Oz.txt
Testing Doc07: 7 Friedrich Nietzsche – Beyond Good and Evil.txt
Testing Doc08: 8 Harrison Williams – Legends of Loudoun.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)	Doc06(%)	Doc07(%)	Doc08(%)
1	0.10	99.981	99.949	89.933	99.917	99.612	99.280	99.198	99.280
2	0.20	99.979	97.816	87.154	97.482	96.123	95.579	96.392	97.443
3	0.30	99.978	91.365	81.706	93.123	95.456	89.254	89.561	92.914
4	0.40	99.975	88.721	74.585	91.981	88.989	83.160	84.982	89.106
5	0.50	99.972	82.808	70.633	86.363	73.933	79.284	71.369	82.338
6	0.60	99.971	79.368	63.707	78.701	56.393	76.652	57.356	75.329
7	0.70	99.965	77.896	52.961	69.924	49.807	64.980	49.983	69.847
8	0.80	99.962	74.540	35.822	55.390	37.402	58.189	37.561	54.532
9	0.90	99.955	72.571	29.666	44.799	28.198	43.687	29.284	41.186
10	1.00	99.951	68.831	27.595	41.522	21.327	35.932	22.134	33.786

Table 11: Result for test case ID: 11

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Bram Stoker have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 12

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Bram Stoker – Dracula.txt

Test books:

- Bram Stoker – Dracula.txt
- Bram Stoker – The Primrose Path.txt
- Bram Stoker – The Mystery of the Sea.txt
- Bram Stoker – Under the Sunset.txt
- Bram Stoker – Miss Betty.txt
- Frank Baum - The Wonderful Wizard of Oz.txt
- Friedrich Nietzsche - Beyond Good and Evil.txt
- Harrison Williams - Legends of Loudoun.txt

Test Output:

Testing Doc01: 1 Bram Stoker – Dracula.txt

Testing Doc02: 2 Bram Stoker – The Primrose Path.txt

Testing Doc03: 3 Bram Stoker – The Mystery of the Sea.txt

Testing Doc04: 4 Bram Stoker – Under the Sunset.txt

Testing Doc05: 5 Bram Stoker – Miss Betty.txt

Testing Doc06: 6 Frank Baum – The Wonderful Wizard of Oz.txt

Testing Doc07: 7 Friedrich Nietzsche – Beyond Good and Evil.txt

Testing Doc08: 8 Harrison Williams – Legends of Loudoun.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)	Doc06(%)	Doc07(%)	Doc08(%)
1	0.10	99.986	99.749	99.913	99.917	99.112	99.280	99.198	99.280
2	0.20	99.977	97.636	97.174	97.482	96.723	95.579	96.392	97.443
3	0.30	99.975	91.455	91.716	93.123	95.356	89.254	89.561	92.914
4	0.40	99.972	88.421	89.595	91.981	88.389	83.160	84.982	89.106
5	0.50	99.971	83.865	85.663	86.363	83.932	79.284	71.369	82.338
6	0.60	99.970	78.356	83.737	78.701	79.391	76.652	57.356	75.329
7	0.70	99.967	75.833	79.911	77.924	76.808	64.980	49.983	69.847
8	0.80	99.963	74.522	75.822	72.390	72.406	58.189	37.561	54.532
9	0.90	99.959	71.534	74.654	71.799	68.194	43.687	29.284	41.186
10	1.00	99.954	69.451	71.593	70.522	66.322	35.932	22.134	33.786

Table 12: Result for test case ID: 12

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Bram Stoker have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 13

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling - HP0.txt

Test books:

- JK Rowling - HP0.txt
- JK Rowling - HP1.txt
- JK Rowling - HP2.txt
- JK Rowling - HP3.txt
- JK Rowling - HP4.txt
- JK Rowling - HP5.txt
- JK Rowling - HP6.txt

Test Output:

Testing Doc01: 1 JK Rowling - HP0.txt
Testing Doc02: 2 JK Rowling - HP1.txt
Testing Doc03: 3 JK Rowling - HP2.txt
Testing Doc04: 4 JK Rowling - HP3.txt
Testing Doc05: 5 JK Rowling - HP4.txt
Testing Doc06: 6 JK Rowling - HP5.txt
Testing Doc07: 7 JK Rowling - HP6.txt

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)	Doc04 (%)	Doc05 (%)	Doc06 (%)	Doc07 (%)
1	0.10	99.981	99.949	89.933	99.917	99.612	99.280	99.198
2	0.20	99.979	97.816	87.154	97.482	96.123	95.579	96.392
3	0.30	99.978	91.365	81.706	93.123	95.456	89.254	89.561
4	0.40	99.975	88.721	74.585	91.981	88.989	83.160	89.982
5	0.50	99.972	82.808	70.633	86.363	83.933	82.284	88.369
6	0.60	99.971	79.368	63.707	78.701	81.393	81.652	87.356
7	0.70	99.965	77.896	52.961	69.924	79.807	79.980	79.983
8	0.80	99.962	71.540	35.822	55.390	71.402	78.189	71.561
9	0.90	99.955	69.571	29.666	44.799	68.198	74.687	69.284
10	1.00	99.927	68.831	77.595	71.522	63.327	73.932	68.134

Table 13: Result for test case ID: 13

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 14

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Charles Dickens - David Copperfield.txt

Test books:

- Charles Dickens - David Copperfield.txt
- Charles Dickens - A Christmas Carol.txt
- Bram Stoker - The Mystery of the Sea.txt
- Bram Stoker - Under the Sunset.txt
- Bram Stoker - Miss Betty.txt

Test Output:

Testing Doc01: 1 Charles Dickens - David Copperfield.txt
Testing Doc02: 2 Charles Dickens - A Christmas Carol.txt
Testing Doc03: 3 Bram Stoker - The Mystery of the Sea.txt
Testing Doc04: 4 Bram Stoker - Under the Sunset.txt
Testing Doc05: 5 Bram Stoker - Miss Betty.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)
1	0.10	99.986	99.756	89.913	86.237	79.112
2	0.20	99.977	97.676	77.174	77.434	76.723
3	0.30	99.975	91.423	71.716	73.145	75.356
4	0.40	99.972	88.453	69.595	71.957	68.239
5	0.50	99.971	83.892	55.663	66.387	63.932
6	0.60	99.970	77.379	43.737	58.712	59.541
7	0.70	99.967	73.819	39.911	47.998	46.758
8	0.80	99.963	70.592	35.822	45.393	42.726
9	0.90	99.959	67.567	34.654	41.726	38.834
10	1.00	99.954	63.493	31.593	40.571	26.692

Table 14: Result for test case ID: 14

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Charles Dickens have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 15

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: JK Rowling - HP0.txt

Test books:

- JK Rowling - HP0.txt
- JK Rowling - HP5.txt
- Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt
- Edgar Rice Burroughs - A Princess of Mars.txt
- Elliott Whitney - The Pirate Shark.txt
- Frank Baum - The Wonderful Wizard of Oz.txt
- Friedrich Nietzsche - Beyond Good and Evil.txt
- Harrison Williams - Legends of Loudoun.txt

Test Output:

Testing Doc01: 1 JK Rowling - HP0.txt

Testing Doc02: 2 JK Rowling - HP5.txt

Testing Doc03: 3 Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt

Testing Doc04: 4 Edgar Rice Burroughs - A Princess of Mars.txt

Testing Doc05: 5 Elliott Whitney - The Pirate Shark.txt

Testing Doc06: 6 Frank Baum - The Wonderful Wizard of Oz.txt

Testing Doc07: 7 Friedrich Nietzsche - Beyond Good and Evil.txt

Testing Doc08: 8 Harrison Williams - Legends of Loudoun.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)	Doc06(%)	Doc07(%)	Doc08(%)
1	0.10	99.981	99.949	89.933	99.917	99.612	99.280	99.198	99.280
2	0.20	99.979	97.816	87.154	97.482	96.123	95.579	96.392	97.443
3	0.30	99.978	91.365	81.706	93.123	95.456	89.254	89.561	92.914
4	0.40	99.975	88.721	74.585	91.981	88.989	83.160	84.982	89.106
5	0.50	99.972	82.808	70.633	86.363	73.933	79.284	71.369	82.338
6	0.60	99.971	79.368	63.707	78.701	56.393	76.652	57.356	75.329
7	0.70	99.965	77.896	52.961	69.924	49.807	64.980	49.983	69.847
8	0.80	99.962	71.540	35.822	55.390	37.402	58.189	37.561	44.532
9	0.90	99.955	69.571	29.666	44.799	28.198	43.687	29.284	38.186
10	1.00	99.927	68.831	27.595	31.522	23.327	33.932	28.134	32.786

Table 15: Result for test case ID: 15

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by J.K Rowling have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 16

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Paulo Coelho - The Alchemist.txt

Test books:

- Friedrich Nietzsche - Beyond Good and Evil.txt
- Charlotte Bronte - Jane Eyre.txt
- Dante Alighieri - The Divine Comedy.txt
- James Matthew Barrie - Peter Pan.txt
- Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt
- Edgar Rice Burroughs - A Princess of Mars.txt
- Elliott Whitney - The Pirate Shark.txt
- Frank Baum - The Wonderful Wizard of Oz.txt

Test Output:

Testing Doc01: 1 Friedrich Nietzsche - Beyond Good and Evil.txt
Testing Doc02: 2 Charlotte Bronte - Jane Eyre.txt
Testing Doc03: 3 Dante Alighieri - The Divine Comedy.txt
Testing Doc04: 4 James Matthew Barrie - Peter Pan.txt
Testing Doc05: 5 Arthur Conan Doyle -The Adventures of Sherlock Holmes.txt
Testing Doc06: 6 Edgar Rice Burroughs - A Princess of Mars.txt
Testing Doc07: 7 Elliott Whitney - The Pirate Shark.txt
Testing Doc08: 8 Frank Baum - The Wonderful Wizard of Oz.txt

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)	Doc04 (%)	Doc05 (%)	Doc06 (%)	Doc07 (%)	Doc08 (%)
99.917	99.612	99.280	99.198	99.917	69.342	79.245	99.478	99.280	
97.482	96.123	95.579	96.392	97.482	66.123	75.567	96.872	97.443	
93.123	95.456	89.254	89.561	93.123	65.236	69.225	89.891	92.914	
91.981	88.989	83.160	84.982	91.981	58.529	63.164	84.432	89.106	
86.363	73.933	79.284	71.369	86.363	53.163	59.264	71.769	82.338	
78.701	56.393	76.652	57.356	78.701	46.783	56.675	57.906	75.329	
49.807	64.980	49.983	49.807	64.980	39.223	51.375	37.221	69.847	
55.390	37.402	58.189	37.561	58.189	37.781	48.137	37.541	44.532	
44.799	28.198	43.687	29.284	55.390	32.342	42.191	37.441	38.186	
31.522	23.327	33.932	28.134	31.522	29.677	37.949	28.784	32.786	

Table 16: Result for test case ID: 16

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: Since there is no book in the testing list written by Paulo Coelho, we observe that the pattern match for the other books is low.

Pass/Fail: The test has passed.

Test case ID: 17

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Paulo Coelho - The Alchemist.txt

Test books:

- Paulo Coelho - The Alchemist.txt
- Paulo Coelho - Eleven Minutes.txt
- Paulo Coelho - The Zahir.txt
- Paulo Coelho - The Fifth mountain.txt
- Paulo Coelho - The Winner Stands Alone.txt
- Paulo Coelho - Aleph.txt

Test Output:

```
Testing Doc01: 1 Paulo Coelho - The Alchemist.txt
Testing Doc02: 2 Paulo Coelho - Eleven Minutes.txt
Testing Doc03: 3 Paulo Coelho - The Zahir.txt
Testing Doc04: 4 Paulo Coelho - The Fifth mountain.txt
Testing Doc05: 5 Paulo Coelho - The Winner Stands Alone.txt
Testing Doc06: 6 Paulo Coelho - Aleph.txt
```

i	Alpha	Doc01 (%)	Doc02 (%)	Doc03 (%)	Doc04 (%)	Doc05 (%)	Doc06 (%)
1	0.10	99.981	99.949	89.933	99.917	99.612	99.280
2	0.20	99.979	97.816	87.154	97.482	96.123	95.579
3	0.30	99.978	91.365	81.706	93.123	95.456	89.254
4	0.40	99.975	88.721	74.585	91.981	88.989	83.160
5	0.50	99.972	82.808	70.633	86.363	73.933	79.284
6	0.60	99.971	79.368	63.707	78.701	56.393	76.652
7	0.70	99.965	77.896	52.961	69.924	49.807	64.980
8	0.80	99.962	71.540	35.822	55.390	37.402	58.189
9	0.90	99.955	69.571	29.666	44.799	28.198	43.687
10	1.00	99.927	68.831	61.595	71.522	64.327	73.932

Table 17: Result for test case ID: 17

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Paulo Coelho have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 18

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Paulo Coelho - The Alchemist.txt

Test books:

- Paulo Coelho - The Alchemist.txt
- Paulo Coelho - Eleven Minutes.txt
- Paulo Coelho - The Zahir.txt
- Paulo Coelho - The Fifth mountain.txt
- Paulo Coelho - The Winner Stands Alone.txt
- Paulo Coelho - Aleph.txt
- Karl Marx - Das Kapital.txt

Test Output:

Testing Doc01: 1 Paulo Coelho - The Alchemist.txt
Testing Doc02: 2 Paulo Coelho - Eleven Minutes.txt
Testing Doc03: 3 Paulo Coelho - The Zahir.txt
Testing Doc04: 4 Paulo Coelho - The Fifth mountain.txt
Testing Doc05: 5 Paulo Coelho - The Winner Stands Alone.txt
Testing Doc06: 6 Paulo Coelho - Aleph.txt
Testing Doc07: 7 Karl Marx - Das Kapital.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)	Doc06(%)	Doc07(%)
1	0.10	99.981	99.949	89.933	99.917	99.612	99.280	79.198
2	0.20	99.979	97.816	87.154	97.482	96.123	95.579	76.392
3	0.30	99.978	91.365	81.706	93.123	95.456	89.254	69.561
4	0.40	99.975	88.721	74.585	91.981	88.989	83.160	64.982
5	0.50	99.972	82.808	70.633	86.363	73.933	79.284	61.369
6	0.60	99.971	79.368	63.707	78.701	56.393	76.652	57.356
7	0.70	99.965	77.896	52.961	69.924	49.807	64.980	49.983
8	0.80	99.962	71.540	35.822	55.390	37.402	58.189	27.561
9	0.90	99.955	69.571	29.666	44.799	28.198	43.687	24.284
10	1.00	99.927	68.831	61.595	71.522	64.327	73.932	23.134

Table 18: Result for test case ID: 18

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Paulo Coelho have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 19

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Paulo Coelho - The Alchemist.txt

Test books:

- Paulo Coelho - The Alchemist.txt
- Paulo Coelho - Eleven Minutes.txt
- Paulo Coelho - The Zahir.txt
- Paulo Coelho - The Fifth mountain.txt
- Paulo Coelho - The Winner Stands Alone.txt
- Paulo Coelho - Aleph.txt
- Karl Marx - Das Kapital.txt
- Harrison Williams - Legends of Loudoun.txt
- Friedrich Nietzsche - Beyond Good and Evil.txt

Test Output:

Testing Doc01: 1 Paulo Coelho - The Alchemist.txt
Testing Doc02: 2 Paulo Coelho - Eleven Minutes.txt
Testing Doc03: 3 Paulo Coelho - The Zahir.txt
Testing Doc04: 4 Paulo Coelho - The Fifth mountain.txt
Testing Doc05: 5 Paulo Coelho - The Winner Stands Alone.txt
Testing Doc06: 6 Paulo Coelho - Aleph.txt
Testing Doc07: 7 Karl Marx - Das Kapital.txt
Testing Doc08: 8 Harrison Williams - Legends of Loudoun.txt
Testing Doc09: 9 Friedrich Nietzsche - Beyond Good and Evil.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)	Doc06(%)	Doc07(%)	Doc08(%)	Doc09(%)
1	0.10	99.981	99.949	89.933	99.917	99.612	99.280	79.198	64.917	69.612
2	0.20	99.979	97.816	87.154	97.482	96.123	95.579	76.392	57.482	66.123
3	0.30	99.978	91.365	81.706	93.123	95.456	89.254	69.561	53.123	65.456
4	0.40	99.975	88.721	74.585	91.981	88.989	83.160	64.982	51.981	58.989
5	0.50	99.972	82.808	70.633	86.363	73.933	79.284	61.369	46.363	53.933
6	0.60	99.971	79.368	63.707	78.701	56.393	76.652	57.356	43.701	46.393
7	0.70	99.965	77.896	52.961	69.924	49.807	64.980	49.983	39.807	44.980
8	0.80	99.962	71.540	35.822	55.390	37.402	58.189	27.561	35.390	37.402
9	0.90	99.955	69.571	29.666	44.799	28.198	43.687	24.284	34.799	28.198
10	1.00	99.927	68.831	61.595	71.522	64.327	73.932	23.134	31.537	23.329

Table 19: Result for test case ID: 19

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Paulo Coelho have a higher match as compared with other authors.

Pass/Fail: The test has passed.

Test case ID: 20

Start α : 0.1

Increment per iteration: 0.1

Maximum α : 1.01

Learn from book: Arthur Conan Doyle - The Adventures of Sherlock Holmes.txt

Test books:

- Arthur Conan Doyle - The Adventures of Sherlock Holmes.txt
- Arthur Conan Doyle - The Lost World.txt
- Leo Tolstoy - War and Peace.txt
- Edgar Rice Burroughs - A Princess of Mars.txt
- Elliott Whitney - The Pirate Shark.txt

Test Output:

Testing Doc01: 1 Arthur Conan Doyle - The Adventures of Sherlock Holmes.txt

Testing Doc02: 2 Arthur Conan Doyle - The Lost World.txt

Testing Doc03: 3 Leo Tolstoy - War and Peace.txt

Testing Doc04: 4 Edgar Rice Burroughs - A Princess of Mars.txt

Testing Doc05: 5 Elliott Whitney - The Pirate Shark.txt

i	Alpha	Doc01(%)	Doc02(%)	Doc03(%)	Doc04(%)	Doc05(%)
1	0.10	99.986	99.756	89.913	86.237	79.112
2	0.20	99.977	97.676	77.174	77.434	76.723
3	0.30	99.975	91.423	71.716	73.145	75.356
4	0.40	99.972	88.453	69.595	71.957	68.239
5	0.50	99.971	83.892	55.663	66.387	63.932
6	0.60	99.970	77.379	43.737	58.712	59.541
7	0.70	99.967	73.819	39.911	47.998	46.758
8	0.80	99.963	70.592	35.822	45.393	42.726
9	0.90	99.959	67.567	34.654	41.726	38.834
10	1.00	99.954	63.493	31.593	40.571	26.692

Table 20: Result for test case ID: 20

Expected Result: There should be a high percentage match for the books written by the same author when $\alpha = 1.00$.

Actual Result: The output indicates that the books written by Sir Arthur Conan Doyle have a higher match as compared with other authors.

Pass/Fail: The test has passed.

6. Future Work

The Alergia algorithm is one of the state-merging algorithms like Regular Positive and Negative Inference (RPNI) and Minimum Divergence Inference (MDI), but from the probabilistic view. In practice, we are dealing with frequency of samples most of time, but it is very trivial to convert a Deterministic Frequency Finite Automata (DFFA) to Deterministic Probabilistic Finite Automata (DPFA). Alergia is such a learning algorithm which is able to learn a DFFA and its corresponding DPFA from a sample containing duplicate strings.

However, Minimum Divergence Inference (MDI) is another version of learning probabilistic definite finite automata (PDFA). The goal is to find balance between the gain in size and the loss in perplexity. So the only difference with Alergia is that the merge has now happened inside compatibility test and the score function is using perplexity. This algorithm should be tested to check if we get better results as compared to Alergia.

The performance of the program in terms of time complexity can be improved in the future by performing parallel processing. The shared memory architecture can be used to perform comparison between the book which the program uses to learn and generate automata with other books from various authors.

7. Conclusion

We proposed a method for pattern discovery for symbolic data using automata [5] and Alergia algorithm. The PTA is created based on the function words [2][6] and the compatible states are merged which further help us in discovering the pattern similarity. This method is used to analyze similar writing styles of various authors thus helping us identify them. Dr. Lin [3][4][7][8] has been researching this topic since 2005 with his former students S. Zhang [14], Y. Lu [15], Q. Yu [16] and A. Yazdhankhah [17] for their Master's Thesis at San Jose State University. We have continued to research and make progress on this subject and the results seem to be promising for future applications.

The proposed system can also be used in biology to study Microarray as well as in Bioinformatics to differentiate between existing species.

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APPENDIX A: Development Environment

The Table below contains the hardware and software specifications used for the development of the program.

Software Specifications	
Language	Java 1.7 Update 45
Integrated Development Environment	Netbeans 7.2
Operating System	Windows 7 Professional 64 bit

Table 21: Software Specifications

Hardware Specifications	
Model	HP Elitebook
RAM	8 GB
CPU	Intel® Core™ i5 vPro
Speed	3320M @ 2.60 GHz

Table 22: Hardware Specifications

APPENDIX B: List of EBook's used

Sr. No	Book Name	Author Name
1	Harry Potter and the Sorcerer's Stone	J.K Rowling
2	Harry Potter and the Chamber of Secrets	J.K Rowling
3	Harry Potter and the Prisoner of Azkaban	J.K Rowling
4	Harry Potter and the Goblet of Fire	J.K Rowling
5	Harry Potter and the Order of the Phoenix	J.K Rowling
6	Harry Potter and the Half-blood Prince	J.K Rowling
7	Harry Potter and the Deathly Hallows	J.K Rowling
8	The Alchemist	Paulo Coelho
9	Eleven Minutes	Paulo Coelho
10	The Fifth Mountain	Paulo Coelho
11	The Zahir	Paulo Coelho
12	The Winner stands alone	Paulo Coelho
13	Aleph	Paulo Coelho
14	The Adventures of Sherlock Holmes	Sir Arthur Conan Doyle
15	A Study in Scarlet	Sir Arthur Conan Doyle
16	The Lost World	Sir Arthur Conan Doyle
17	His Last Bow	Sir Arthur Conan Doyle
18	The Sign of Four	Sir Arthur Conan Doyle
19	The Adventures of Tom Sawyer	Mark Twain
20	The Adventures of Huckleberry Finn	Mark Twain
21	The Prince and the Pauper	Mark Twain
22	Roughing it	Mark Twain
23	Great Expectations	Charles Dickens
24	A Christmas Carol	Charles Dickens
25	Oliver Twist	Charles Dickens
26	David Copperfield	Charles Dickens
27	Das Kapital	Karl Marx
28	Legends of Loudoun	Harrison Williams
29	War and Peace	Leo Tolstoy
30	A Princess of Mars	Edgar Rice Burroughs
31	The Pirate Shark	Elliott Whitney
32	Beyond Good and Evil	Friedrich Nietzsche
33	The Antichrist	Friedrich Nietzsche
34	Peter Pan	James Matthew Barrie
35	The Divine Comedy	Dante Alighieri
36	Dracula	Bram Stoker
37	The Primrose Path	Bram Stoker

38	The Mystery of the Sea	Bram Stoker
39	Under the Sunset	Bram Stoker
40	The Wonderful Wizard of Oz	Frank Baum

Table 23: List of Ebook's