Machine Learning & Data Mining
Miniproject 2

Caltech CS/CNS/EE 155
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1 Introduction

- **Group members:** Enrico Borba, Claire Goeckner-Wald
- **Team name:** Papa Mart's Mini Gary - The Comeback
- **Division of labour:** Enrico Borba: Programming, ideas, report visualization. Claire Goeckner-Wald: Programming, ideas, report assembly.

2 Pre-processing

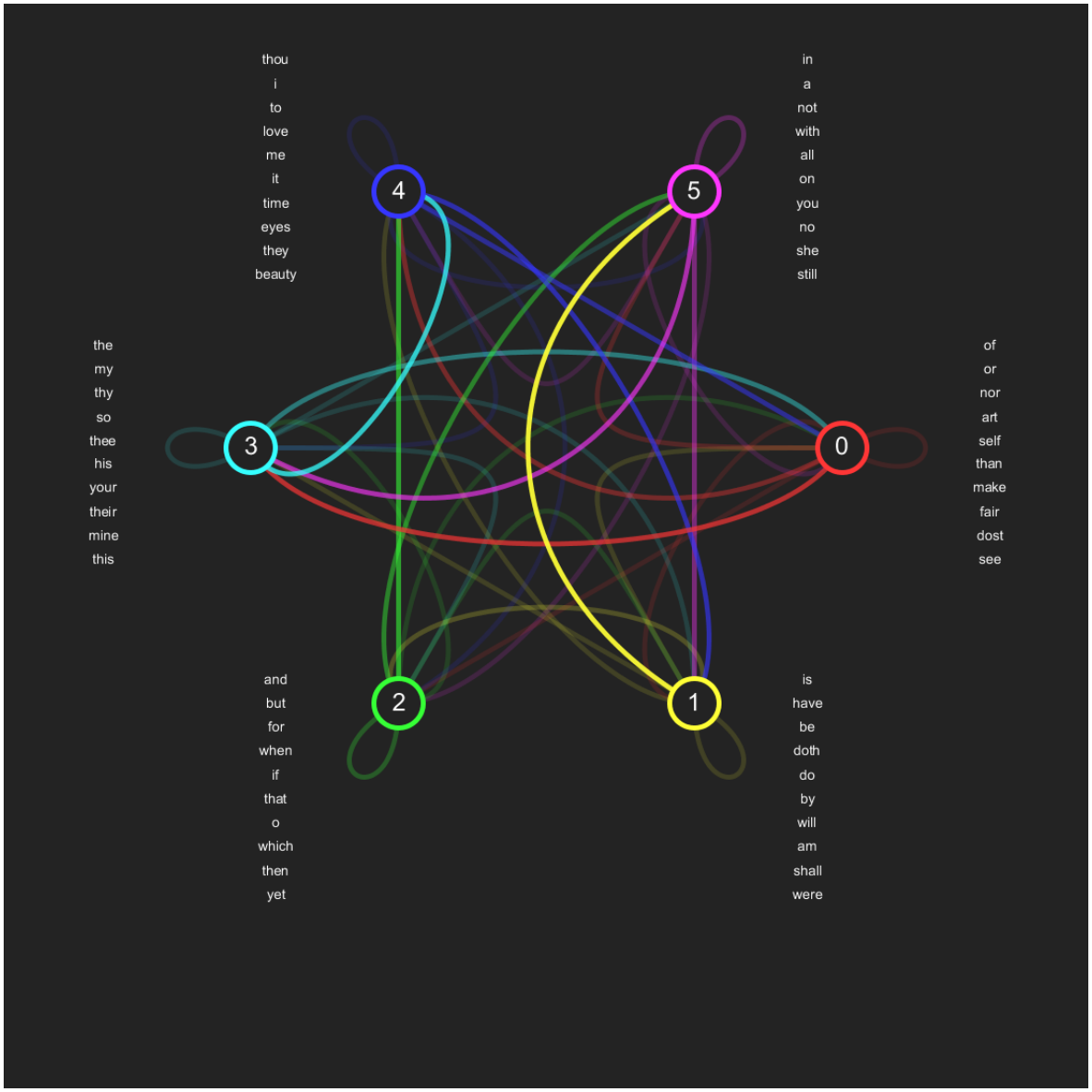
- **Handling the dataset**
  - **Quatrains versus couplets:** Initially, we thought that we should train two different models, one on lines from the quatrains, and one on lines from the couplets. This way, we could more accurately capture the "shift in tone" that Shakespeare often performs during his sonnets. However, since we decided to 'force' rhyming using a rhyming dictionary garnered from the dataset, we ended up combining quatrains and couplets into one model.
  - **Punctuation:** We stripped the following punctuation from the sonnet data, including the parentheses: $, . :; !?()$
  - **Tokenization:** We tokenized on the words in the sonnets.
- **The dictionary**
  - **Structure:** We used a standard python dictionary to assign each word or part-of-sentence a unique number. The dictionary was double-encoded, meaning that there was an entry for each word $w \to x$ and each number $x \to w$.
  - **Reason for use:** The HMM would take only numbers, not words or characters. We had to set all word to lowercase first, to avoid using some word "The" in the middle of a sentence, when we would rather have "the".
  - **Unexpected trouble:** The use of the dictionary is also one reason why we decided to treat lines from quatrains and couplets equally. Initially, we had one large dictionary that covered all words Shakespeare used in the dataset. As expected, some words were used only in the couplets, or only in the quatrains. However, we ran into errors when training two separate Hidden Markov Models, most likely because the model expected that if we gave it words (represented by numbers) $\{3, 15, 23, 14, 194\}$, that there would be $(1 - 194)$ states available. However, this was not the case.

3 Unsupervised Learning

- **HMM**
  - **Naive poem generation:**
  - **Package:**
  - **Number of hidden states:**

4 Visualization & Interpretation

- **Interpretations**
  - **Analyzing the model:**
  - **Grammar:** We have noticed that...
  - **Imagery:** The below image shows...



5 Poetry Generation

- **Algorithm**
  - **Two example non-naive sonnets:**

```
1  She have not eyes bright be that tiger's moan
2  Every must change touches thou moan bed
3  But the gold shook all so let and upon
4  Everywhere to although stain full unbred
5  To and i'll so shows care more releasing
6  Be it thee thou fore when your which rehearse
7  They the rage these life of mine possessing
8  Painting therefore thine night a for inhearse
9  His thy spurring prove so from are compiled
10 In leisure in and seeing receives cry
11 To touches strangle thy the to me filed
12 Him my that saith they have my jollity
13     Remain lawful hast I say 'will' annoy
14     A under is his name strong thinks fled joy
```

```
1  If breath to were book you due look rotten
2  Line his in or you steeled my thee shown
3  If wilful-slow grace me when forgotten
4  Of every pen loving summer own
5  Me going deserve with filching not guard
6  Is dear of love in paying live it leaves
7  Blame ever worst o what gazing since ward
8  Your for candles distraction there be sheaves
9  Excel heart others small invention light
10 The with write way thy so health ignorance
11 Then which thus do beweep need'st them aright
12 And an far day back my in count advance
13     All and face lo an sweets sight over-plus
14     My respect triumph it uncertain thus
```

  - **Algorithm:**

- **Quality of generated poems**
  - **Rhyme and the rhyming dictionary:** We forced rhyming by creating a rhyming dictionary of all of Shakespeare's ending words. We iterated through the sonnets, creating pairs of rhyming words using the known rhyme scheme "ababcdcdefefgg", then used a clumping algorithm to

create super-pairs. For example, $(head, bed)$ and $(head, dead)$ would combine to $(head, bed, dead)$, then search again for additional matches.

- **Rhythmn:**
- **Syllables:** In order to have 10 syllables, per line, we ran a script to gather data on the average number of words per line in Shakespeare's sonnet. The distribution was approximately ([5 words] * 2 , [6 words] * 15 , [7 words] * 41 , [8 words] * 70 , [9 words] * 63 , [10 words] * 25). We used this distribution data to pick a random number of words, generated that many words (minus one, since we picked the ending word to force rhyming), then would continously generate new lines until we had a line that was 10 syllables using our counting algorithm. To count the number of syllables in a line, we mostly used the NLTK. However, there were some words used by Shakespeare that were not included in the NLTK. So, we supplemented this process with a less-accurate but still quite useful syllable-counting algorithm that would give its best guess wherever NTLK failed.
- **Grammar:** The grammar was perhaps the most difficult part of the poems. On occasion, we would get two words in a row, such as "I I" or "the the". More commonly, we would see two parts-of-sentence that did not make sense together, such as "a the", "an a", or "thee thou".
- **Punctuation:** Since we stripped all punctuation during pre-processing, there was minimal punctuation afterwards. Most notably, we would occasionally see the word 'Will', with the apostrophes. We could have easily added ending punctuation, since Shakespeare has a fairly consistent style of , , , :, , , :, , , :, . as line endings. However, we chose not to, for aesthetic reasons.

6 Additional Goals

- **Improving poem quality**
  - **Grammar:**
  - **Rhyme scheme:**
  - **Syllables:**
  - **Punctuation:**