The Equi-complexity vs. Typology: Measurement of Overall Linguistic Complexity and Typological Categories

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1. Purpose

- To demonstrate the similarity of the overall complexities of three major typological categories: agglutinative, fusional, and isolating languages, while:

i) Considering multiple linguistic facets
ii) Dealing with the facets in the same way

2. Background

- It has been believed that no language is simpler/more complex than others; all are equally complex (cf. Hacket, 1958).
- We have not corroborated this belief yet, but some suggest that this belief is true (e.g., Bentz et al. 2022).
- Are agglutinative, fusional, and isolating languages equally complex, or variable in their linguistic complexities?

3. Methodology (Nakayama, 2023)

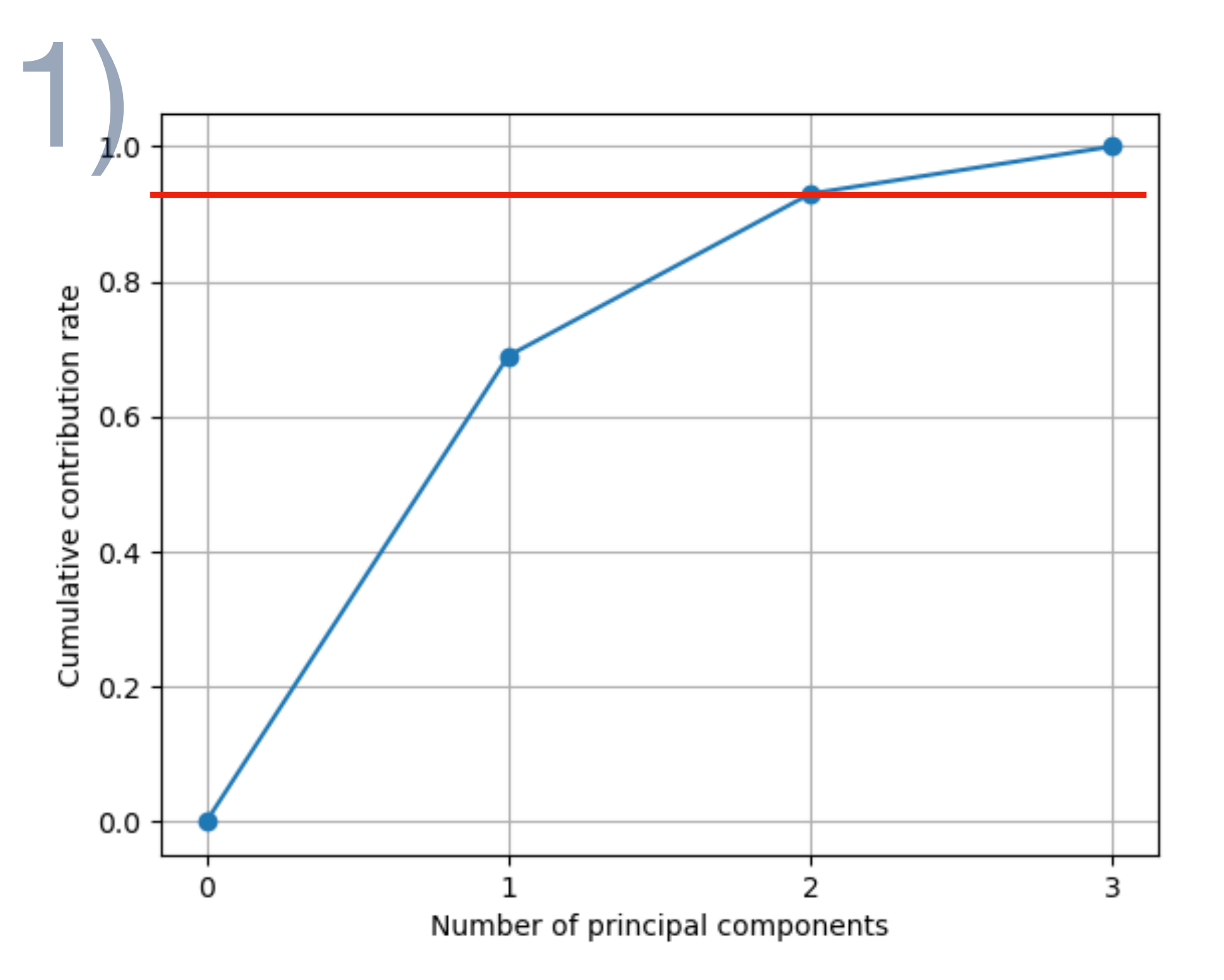
1. Calculate the entropy H (Shannon, 1948) of an n-element sequence from the ith to jth element of a document, the length of which is l:

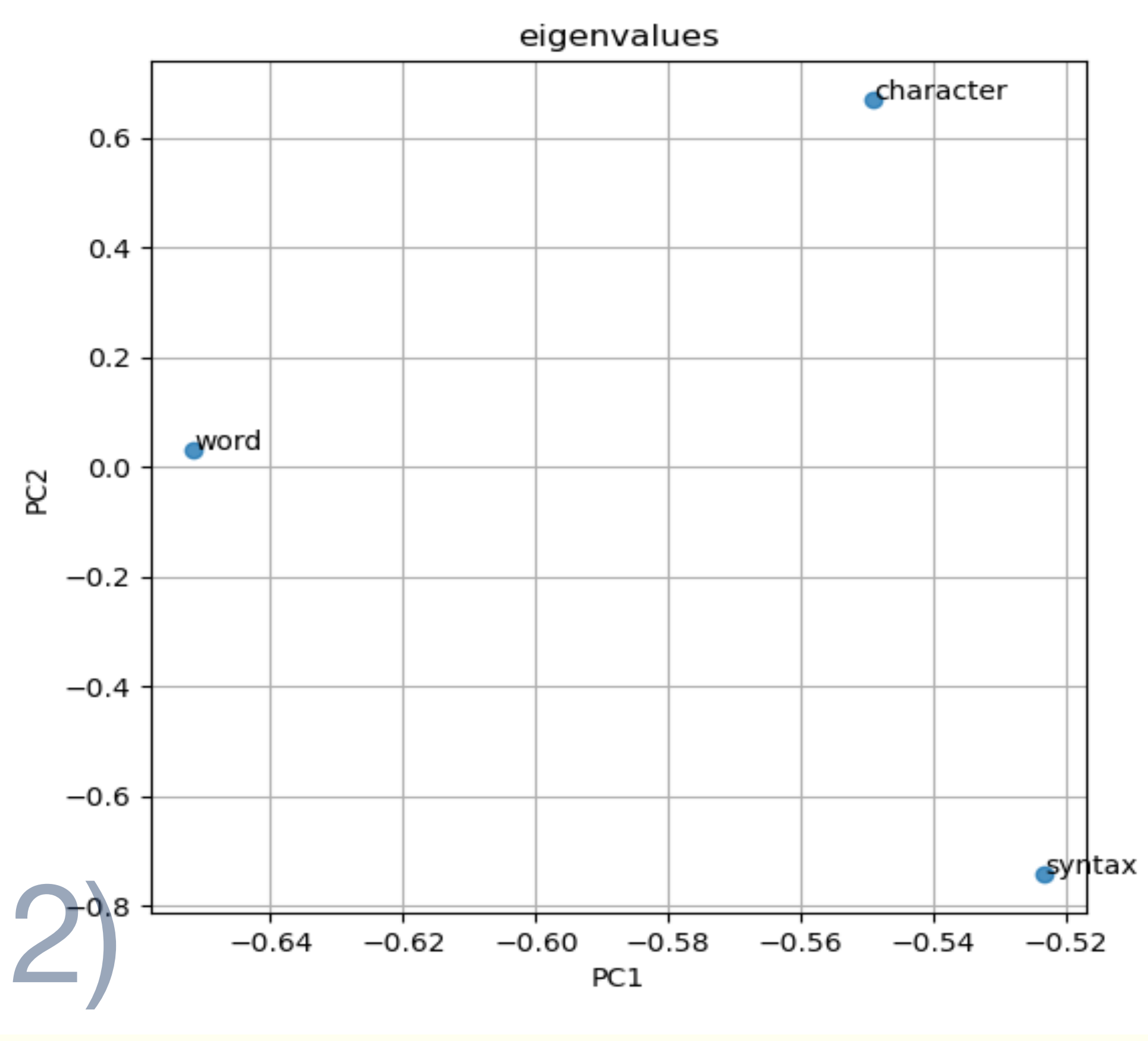
$$H(x_{ij}) = \sum_{i=1,j=n}^{l-n+1,l} \frac{1}{n} p(x_{ij}) \log_2 p(x_{ij}) \ (1 \leq n \leq M) \ ,$$

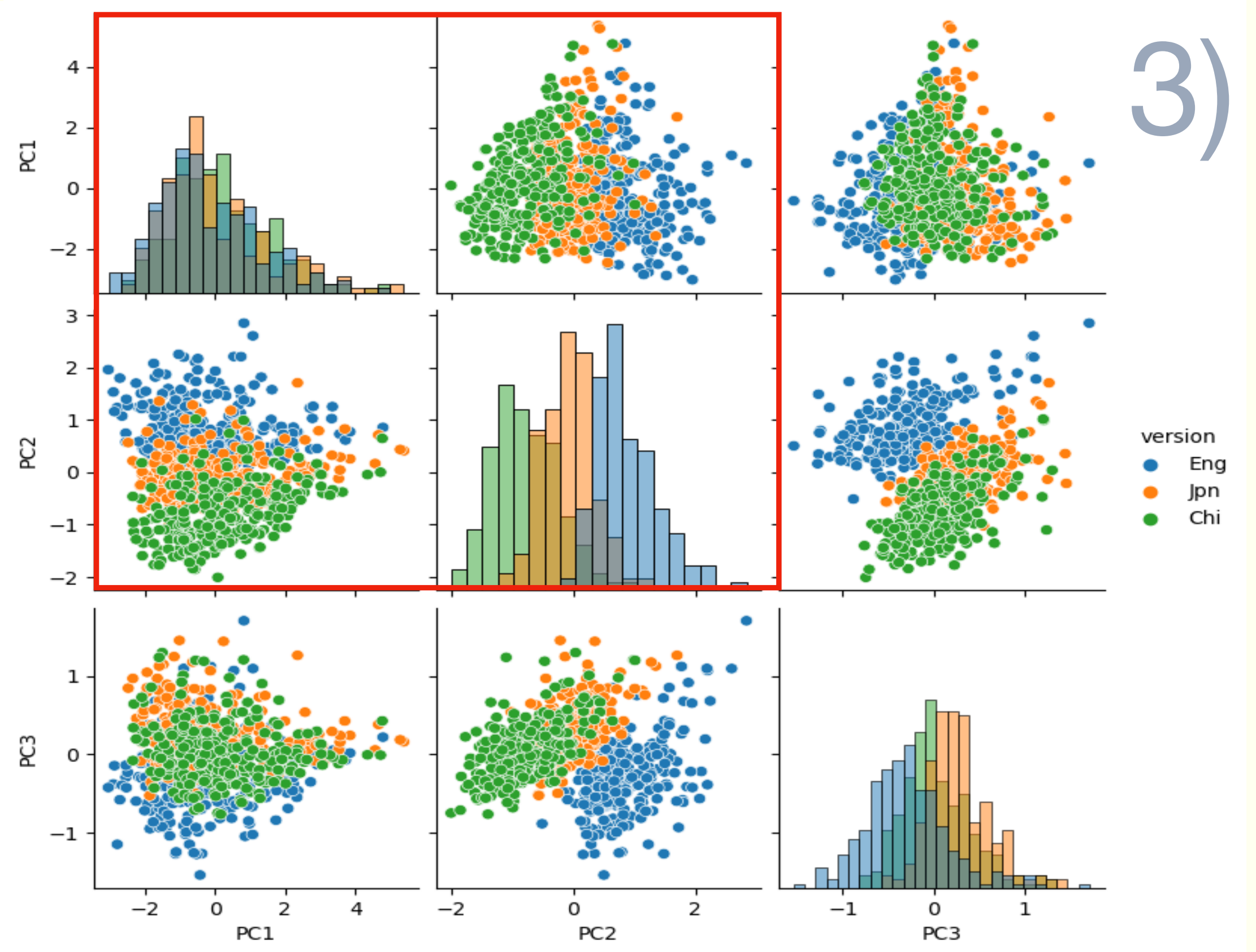
in which M refers to a number great enough to make all the strings different from each other.

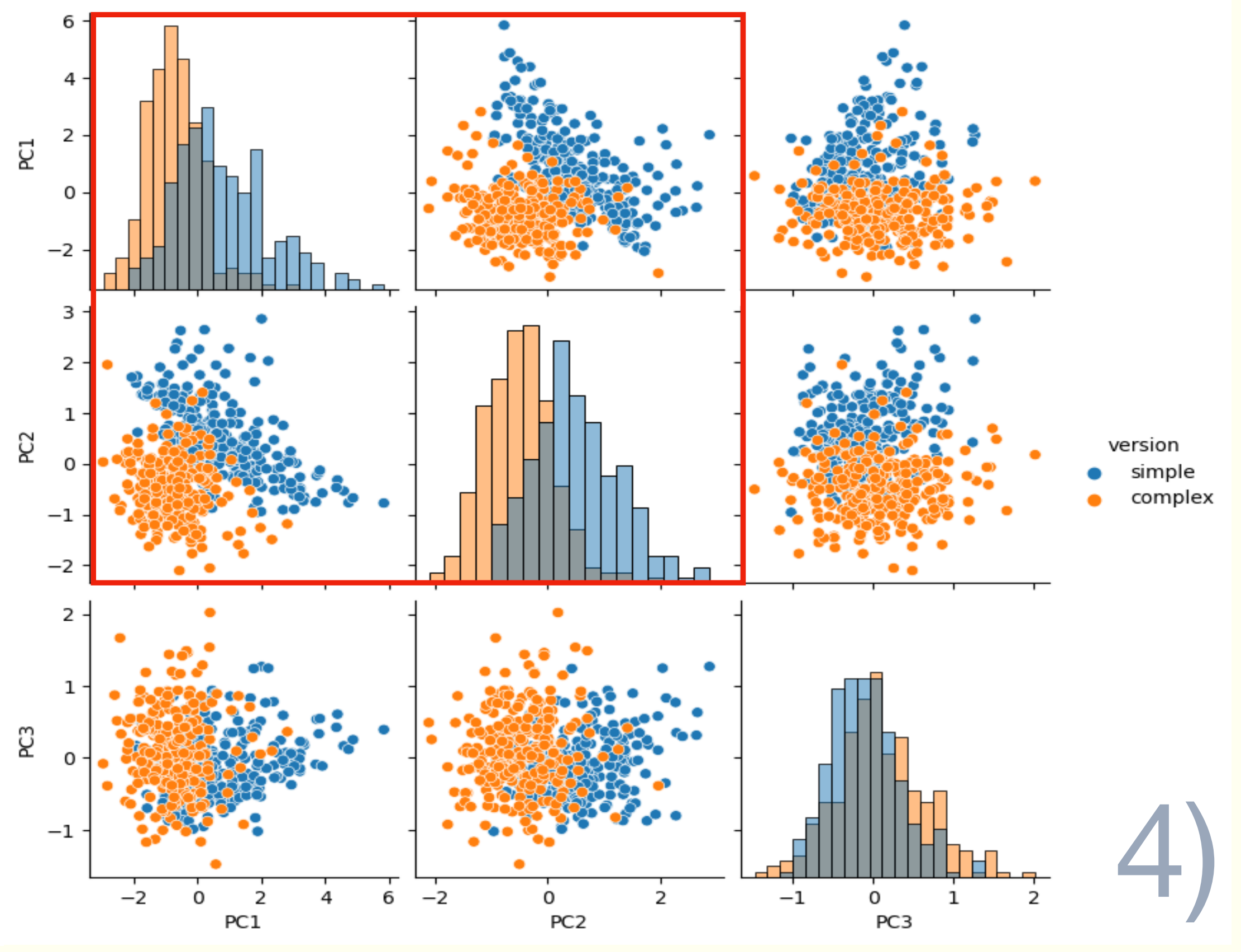
2. Determine the exponent from the power regression of Step 1 as a feature value of the entropy set in which the entropies decrease as n increases.
3. Apply Steps 1 and 2 to multiple facets of each document, such as characters and words, which gives a vector with multiple exponents (cf. Deutscher, 2009).
4. Conduct principal component analysis for the vectors from Step 3.
5. Observe the scatter plots of the principal components.

4. Settings & Results









Dataset

- English, Japanese, and Chinese text of the New Testament
- Demonstrate on three facets: character, word, and syntax
- Syntax: POS tags, tagged by NLTK in Python

1) Cumulative contribution rate
- PC1 + PC2 > 90% of the whole result

2) Eigenvalues
- PC1→an overall complexity
- PC2→PC2 = individual complexities

3) Pair plot 1
- All languages similarly scatter on PC1; they form a slight stripe on PC2

4) Pair plot 2
- Two clusters appear when the dataset is arranged (Nakayama, 2023)

5. Discussion

- All languages have a similar variation on PC1.
→ The overall complexities of languages are similar.
- English texts have a positive eigenvalue on PC2.
→ Character complexity ≥ Syntactic complexity.
- Chinese texts have a negative eigenvalue on PC2.
→ Character complexity ≤ Syntactic complexity.

6. Conclusion and Caveats

- Languages have at least a similar overall complexity, while individual facets have different degrees of complexity.
- The sequence of each facet is not exclusive but includes information about the others
(e.g., character strings does not only represent character complexity itself but also morphological and syntactic complexity).

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