The semantics of roots and patterns in Maltese

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The Maltese verbal system combines Semitic and Non-Semitic language features. Rooted in the Semitic tradition, Maltese utilizes nine verbal *binyanim*[1], i.e. verbal patterns that exhibit fixed slots for consonants and vowels, resulting in distinctive prosodic structures. In addition to this templatic process, Maltese integrates verbs through a concatenative process involving initial gemination and suffixation. While this process is preferred and highly productive, psycholinguistic research indicates that the templatic strategy is still actively used (Spagnol, 2011 and Twist, 2006).

Focusing on the templatic side of Maltese, Spagnol (2011)'s analysis highlights a correlation between the morphophonological shape of the root (weak vs. strong, depending on the existence of the glides w and j) and the binyan used. However, he notes that each binyan lacks a specific function that relates it to others, and that the meaning of a verb is not tied to the binyan it is used with. Building on Spagnol (2011)'s notion, this study investigates the role of meaning in Maltese roots and verbal patterns through distributional semantics.

Using a database of Maltese roots[2] and word embeddings, t-SNE (t-Distributed Stochastic Neighbor Embedding) and KDE (Kernel Density Estimation) analyses were employed to shed light on potential meaning distinctions within and across roots and patterns[3].

The results of the t-SNE analysis of the binyanim (Figure 1) confirms Spagnol (2011)'s notion that meanings of verbs are not associated to specific patterns as no clear clusters are observed. The KDE analysis (Figure 2) suggests varying semantic centroids for strong vs. weak roots across different binyanim, with some exhibiting a clear separation, while others do not. Interestingly, this correlates with morphological productivity. Patterns VIII-X, virtually unproductive according to Spagnol (2011), display a semantic overlap for weak vs. strong roots, while the remaining patterns are separated. Moreover, the shape of the clouds and location of centroids show clear similarities across the binyanim, e.g. II-V and III-VI. Comparing these with Spagnol (2011)'s results shows that binyanim V and VI mark the passives, reflexives and inchoatives of the corresponding transitive verbs in II and III.

These first results provide insights in how the linguistic features root quality and binyanim interact in semantic space for Maltese. Our computational findings based on word embeddings correlate with traditional linguistic metrics such as morphological productivity and transitivity and can contribute to the overall understanding of the morphological and semantic structure of Maltese.

References

Hoberman, Robert D., & Aronoff, Mark (2003), The Verbal Morphology of Maltese, in J. Shimron (ed), (2003), *Languages Processing and Acquisition in Languages of Semitic, Root-based, Morphology*, John Benjamins, 61–78.

Spagnol, Michael (2011), *A Tale of Two Morphologies: Verb structure and argument alternations in Maltese*, Doctoral dissertation, University of Konstanz.

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[1] traditionally represented by Roman numerals I to X; excluding IV in Maltese, see Hoberman & Aronoff (2003) and Spagnol (2011)

[2] downloaded from https://mlrs.research.um.edu.mt/dl/roots.xls

[3] the data and code for the analyses are openly available on OSF: https://osf.io/8x9eh

Twist, Alina E. (2006), *A Psycholinguistic Investigation of the Verbal Morphology of Maltese*, Doctoral dissertation, The University of Arizona.

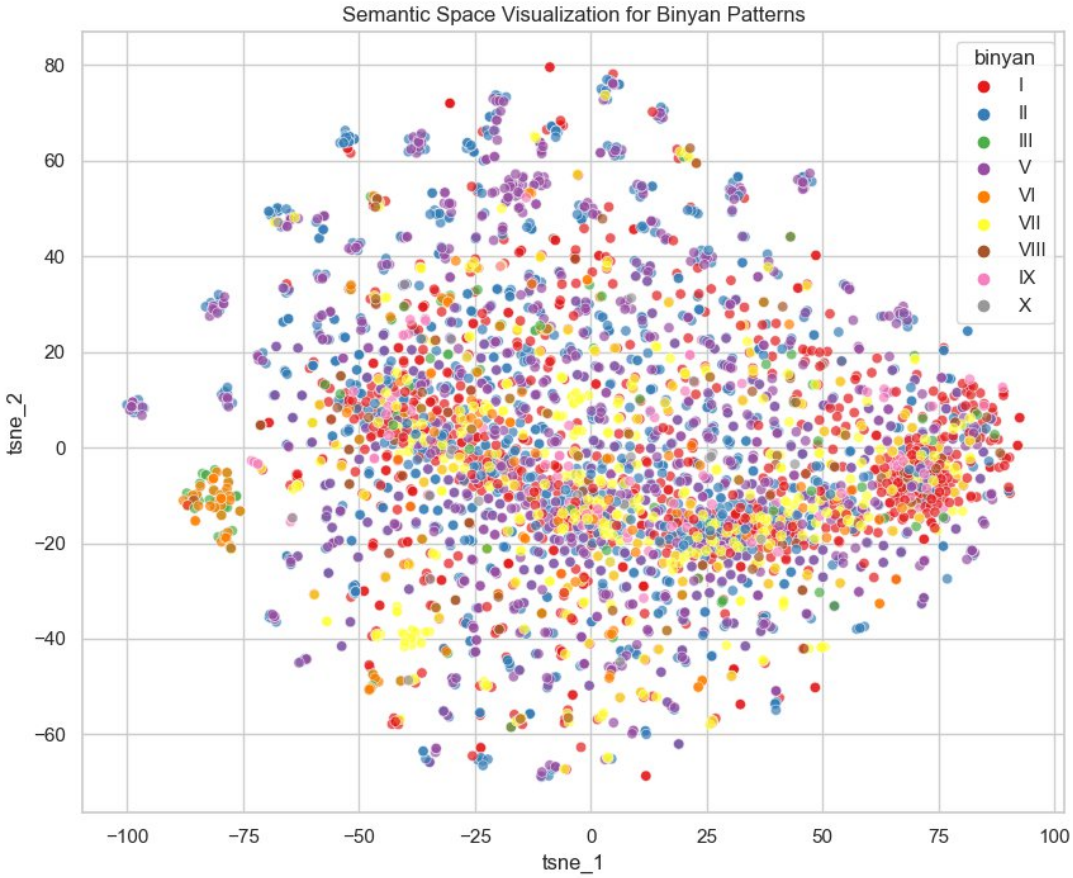

Figure 1: t-SNE analysis of binyan patterns.

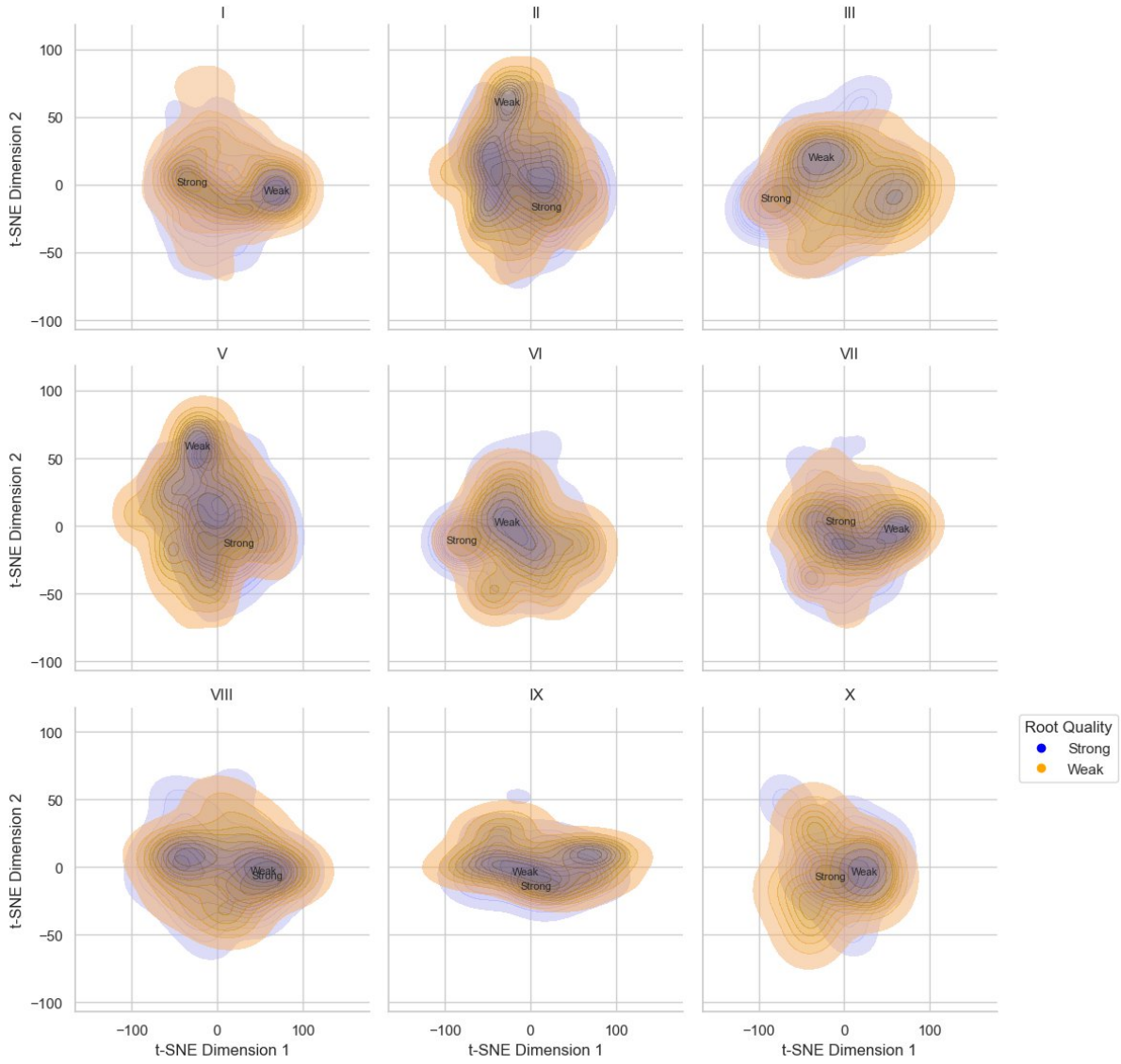

Figure 2: KDE analysis of the interaction of binyanim and roots. Strong roots are represented by purple clouds, weak roots by orange clouds. Maximum density values were calculated and centroids of the clouds were labelled *Strong* or *Weak*, respectively.