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Jetro Vesti

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## Rich square-free words

Jetro Vesti

*University of Turku, Department of Mathematics and Statistics, 20014 Turku, Finland***Abstract**

A word  $w$  is *rich* if it has  $|w| + 1$  distinct palindromic factors, including the empty word. A word is *square-free* if it does not have a factor  $uu$ , where  $u$  is a non-empty word.

Pelantová and Starosta (Discrete Math. 313 (2013)) proved that every infinite rich word contains a square. We will give another proof for that result. Pelantová and Starosta marked with  $r(n)$  the length of a longest rich square-free word on an alphabet of size  $n$ . The exact value of  $r(n)$  was left as an open question. We will give an upper and a lower bound for  $r(n)$ . The lower bound is conjectured to be exact but it is not explicit.

We will also generalize the notion of repetition threshold for a limited class of infinite words. The repetition thresholds for episturmian and rich words are left as an open question.

*Keywords:* Combinatorics on words, Palindromes, Rich words, Square-free words, Repetition threshold.

*2000 MSC:* 68R15

**1. Introduction**

In recent years, rich words and palindromes have been studied extensively in combinatorics on words. A word is a *palindrome* if it is equal to its reversal. In [DJP], the authors proved that every word  $w$  has at most  $|w| + 1$  distinct palindromic factors, including the empty word. The class of words which achieve this limit was introduced in [BHNR] with the term *full* words. When the authors of [GJWZ] studied these words thoroughly they called them *rich* (in palindromes). Since then, rich words have been studied in various papers, for example in [AFMP], [BDGZ1], [BDGZ2], [DGZ], [RR] and [V].

The *defect* of a finite word  $w$ , denoted by  $D(w)$ , is defined as  $D(w) = |w| + 1 - |\text{Pal}(w)|$ , where  $\text{Pal}(w)$  is the set of palindromic factors in  $w$ . The *defect* of an infinite word  $w$  is defined as  $D(w) = \sup\{D(u) \mid u \text{ is a factor of } w\}$ . In other words, the defect is a measure of

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*Email address:* `jejove@utu.fi` (Jetro Vesti)

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