

RISC-V Vector Extension. A Case Study on Time Series Analysis

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This work focuses on the vectorization of the SCAMP algorithm for detecting motifs and discords in time series using the Matrix Profile technique. The Vector Length Agnostic approach of RISC-V, along with its flexibility due to variable vector lengths, positions the RISC-V Vector Extension (RVV) as the most suitable solution for this purpose compared to other architectures.

Matrix Profile and SCAMP

• The goal is to compute the profile and profileIndex vectors, where each element stores the correlation to the nearest matching subsequence and the index of that subsequence, respectively. The process involves four steps:

Data preprocessing: time series normalization and computation of the mean and standard deviation.



3

Experiments conducted on a RISC-V system using gem5 simulator demonstrate a speedup of up to 99× compared to the non-vectorized implementation, employing 8K-bit vector registers and 64-bit floating-point data. This significant performance improvement highlights the efficiency and scalability benefits provided by the dynamic vector configuration capabilities inherent to RISC-V.

Profile computation: maxreduction of the distance matrix to select the maximum correlation value for each subsecuence.



incremental calculation of the Eculidean Distance between

Profile analysis: in order to identify motifs and discords.

SCAMP RVV Vectorization

Distance Matrix calculation

• Vector Length Agnostic approach: hardware can be prompted to reveal the vector register size.

• Adaptative VL: Vector Length dynamically adjusts when the number of remaining

Sliding window 8 2 3 6

Non Vectorized

Vectorized

(vlen 256 = 4 64-bits elements)





iding window

elements is smaller than the maximum capacity, eliminating the need for padding or special tail processing.

• Key SCAMP stages vectorization: correlation, covariance, distance matrix computation, and max-reduction operations are fully vectorized, leading to a substantial decrease in the number of operations as the VLEN increases.







compared to non vectorized version,