Abstract
The purpose of this project is to propose a precondicioner for linear systems with sparse matrices using the inverse matrix calculated with single-precision and compare the results. The importance of this study relies on the use of large space matrices in several mathematical, electrical and engineering problems, and how preconditioners are essential when making calculations with large matrices. The idea of using the single-precision in order to find the precondicioner is motivated by a smaller computational effort when compared to the double one, and yet close enough to the answer.

Key words: Matrix Optimization, Preconditioners, Iterative Methods.

Introduction
Many engineering problems can be posed as a sparse matrix problems. It is common to use matrices with double precision in computational calculations, due to a final solution with more significative figures when compared to single precision. However the use of double precision requires more computational effort. In order to improve the efficiency of computational algorithms, it was opted to solve linear problems using iterative methods: using the very same matrix in single precision as a precondicioner to the double precision matrix.

Results and Discussion
The different methods of solving linear systems, such as Gauss elimination, LU decomposition, LDLT, LDL, Cholesky decompositions and iterative methods like the Rank-1-Update, Steepest Descent and Conjugated Gradient Method were studied. The study was done in 3 stages: a theoretical analysis, the analysis of code developed using Mathematica and a final study of code in C++.

In order to compare the methods studied, we downloaded matrices from The University of Florida Sparse Matrix Collection, all matrices studied were square, positive definite and real. These characteristics are supposed to make the code perform well once theoretical guarantees were respected. Besides that, the function posix_time from the Boost library was used to get the time used in each operation/process.

The main code can be devided into 4 schemes. The first does the Cholesky decomposition of the matrix using double precision. The second in single precision. The third includes the conjugated gradient method, and informs the number of iterations used to find the inverse matrix. The last scheme calculates the linear system using both the preconditioned matrix and the inverse matrix calculated with the conjugated gradient method in single precision and the solution using Cholesky Decomposition directly.

Conclusions
The result demonstrated that the use of the inverse matrix in single-precision as a precondicioner was more effective than the use of no precondicioner for most cases. The differences in the research results might be explained by size of the matrix, the disposition of the non-zeros in the matrix, convergence of the matrix and time to solve the linear sistem. This code has a better performance for large matrices, with at least 90 thousand equations.

Image 1. Time to decompose the matrices studied in float and double using Cholesky decomposition.

Image 2. Time to solve the linear system with precondicioner versus the time to solve the linear system directly in double.

DOi: 10.19146/pibic-2016-51666