# Assignment 2 - Factor Influence Analysis

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The objective of this task was to identify the interactions between two independent variables (optimization techniques and matrix sizes) and the impacts of these on the number of branch and cache loads/misses (dependent variables). The numbers used in this analysis were taken from first assignment and were analysed from the perspective of a $2^2$ factorial design. The results are shown as follows.

## 1. Factor Influence Analysis

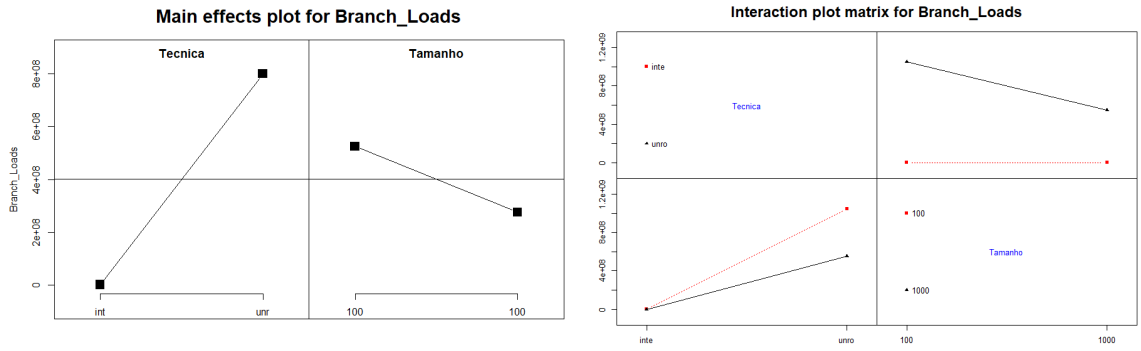
The independent variables and their respective levels are expressed in the following table:

| Variable | Levels |
|---|---|
| Opt. Technique | Loop Unrolling<br>Loop Interchange |
| Matrix Size | 100<br>1000 |

Table 1: Levels of the two independent variables according $2^2$ factorial design.

The analyzes made for each of the dependent variables generated two graphs called "Main effects graph" and "Interaction graph". The results are discussed below.

### 1.1 Branch Loads



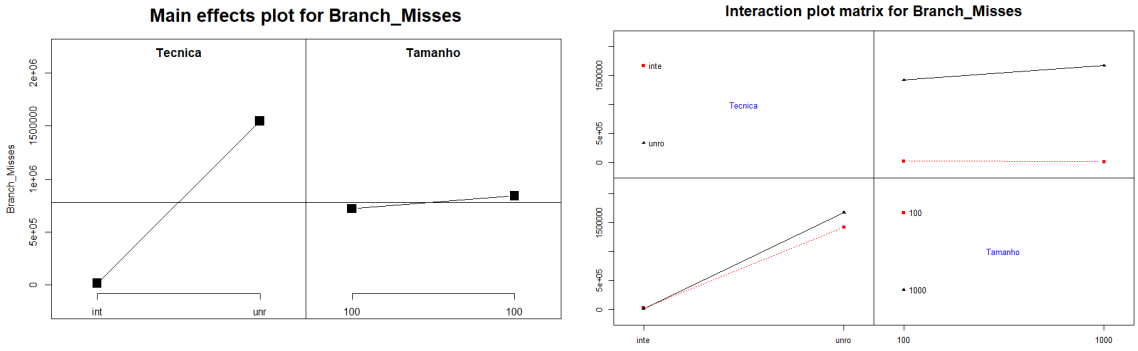

(i) (ii)

Figure 1: (i) Main Effect and (ii) Interaction plots for Branch Loads

The effects of the matrix size on Branch Loads do not appear to be significant when compared to the effect caused by Optimization Technique values. As the analysis of the main effect shows, the difference between the number of Branch Loads when the optimization technique is changed is greater than when the size of the matrix is changed.

However, in terms of interactions, there is definitely an interaction between the independent variables as shown in Figure 1 (ii). The changes are not significant when the Exchange Technique is confronted with the change in the Matrix size. However, a significant response occurs when the Unrolling Technique is faced with changing the size of the matrix. This shows that the optimization technique plays an important role in defining the number of branches taken, especially when the number of calculations increases.

### 1.2 Branch Misses



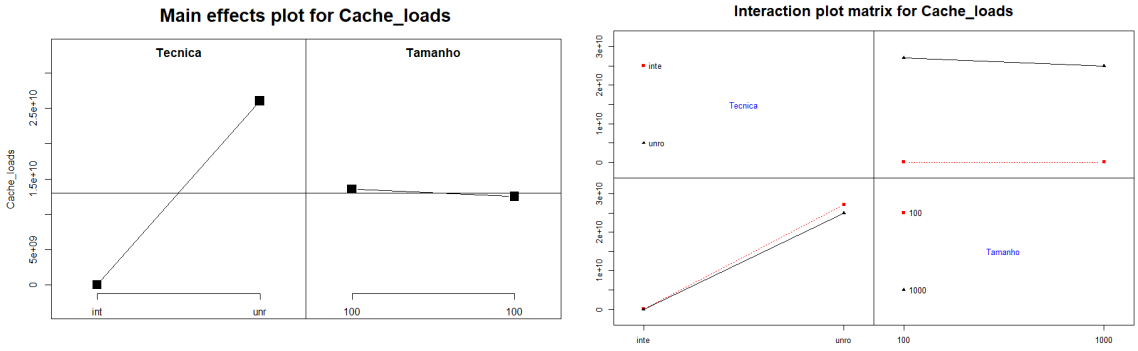

(i) (ii)

Figure 2: (i) Main Effect and (ii) Interaction plots for Branch Misses

The number of Branch Misses seems to be more influenced by the Optimization Technique than by the Matrix Size. As shown in Figure 2 (i), there is a minimal increase in Branch Misses when the size of the matrix changes from 100 to 1000, which does not occur with the different techniques. The graph shows that there is a main effect for the variable "Optimization technique", so that Loop Unrolling technique has a higher score than the Loop Interchange technique.

The lines are almost parallel, as shown in Figure 2 (ii), which indicates that the interactions between the independent variables are not so significant.

### 1.3 Cache Loads



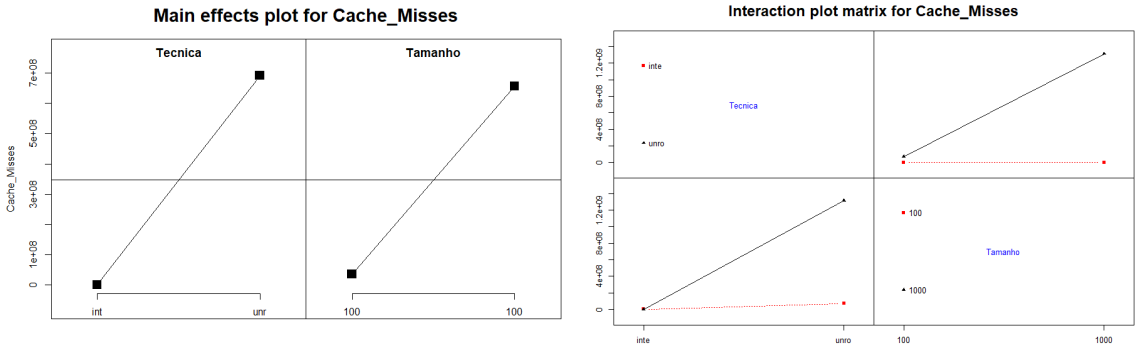

(i) (ii)

Figure 3: (i) Main Effect and (ii) Interaction plots for Cache Loads

The results for Cache Loads were almost the same for Branch Misses: there is main effect for optmization technique so that the Loop Unrolling scored higher than Loop Interchange

on the number of Cache Loads (see Figure 3 (i)). The interactions between the two variables are infimous, since the lines are almost parallel as Figure 3 (ii) shows.

### 1.4 Cache Misses




(i) (ii)

Figure 4: (i) Main Effect and (ii) Interaction plots for Cache Misses

The impacts of the independent variables on the number of Cache Misses are the most notable. There are significant main effects for both variables so that Loop Unrolling scored higher than Interchange Technique and Matrix Size 100 scored higher than M.S. 1000. The situation is no different with the interactions: the variables interact significantly with each other, so that, for the Loop Unrolling technique, the Matrix Size 1000 scored higher than M.S. 100. However, for the Loop Interchange technique, the difference between the results for matrix sizes 100 and 1000 was insignificant.

## 2. Conclusion

In general, as shown in the results, the independent variable that most influences the four variables analyzed (Cache Loads, Cache Misses, Branch Loads and Branch Misses) is the Optimization Technique, whose main effects were significant in all of them. The Matrix Size does not play a significant role, varying only between 100 and 1000. Perhaps the analysis would be different if the values chosen for the Matrix Size had a greater distance between them, but that was not the objective of this study.