# Project Documentation Group 09

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According to the following documentation of computational results for the graph isomorphism project, we aim at a grade of 7.5.

## 1. Category 6: Basic Problem Instances

The basic problem instance have been solved correctly during the programming competition. The following table shows the computation times.

| instance | correctly solved | comp. time (s) |
|---|---|---|
| basicGI1 | ✓ | 2.1 |
| basicGI2 | ✓ | 17.9 |
| basicGI3 | ✓ | 1215.4 |
| basicGIAut | ✓ | 85.2 |
| basicAut1 | ✓ | 13.7 |
| basicAut2 | ✓ | 163.6 |

**Table 1:** *Computation times basic instances.*

## 2. Category +1: Additional Techniques for Faster Algorithms

Not implemented.

## 3. Category +1: Implementation of Fast Partition Refinement

We have implemented the fast partition refinement Algorithm based on Hopcroft's algorithm for DFA minimization of finite automata [1]. In oder to achieve a speedup with this algorithm, we had to use a doubly-linked-list implementation of the color classes of vertices of the graph. The speedup on some sample instances with this algorithm for computing a stable coloring is shown in the tables below.

## 4. Category +1: Using Generating Sets for Computing |Aut(G)|

Not implemented.

## 5. Category +1: Additional and Genuinely New Ideas

Not implemented.

| instance | instance size $\|V\|$ | fast part. ref. times |
|---|---|---|
| torus24.grl | 24 | 1.9 |
| trees36.grl | 36 | 10.7 |
| trees90.grl | 90 | 9.6 |
| bigtrees3.grl | 227 | 60.1 |

**Table 2:** *Computation times for isomorphic pairs with fast partition refinement.*

| instance | instance size $\|V\|$ | # autom. | fast part. ref. |
|---|---|---|---|
| cubes5.grl | 32 | 3840, 24 | 206.1 |
| trees36.grl | 36 | 2, 6 | 5.8 |
| torus24.grl | 24 | 96 | 10.8 |

**Table 3:** *Computation times for number of automorphisms with fast partition refinement.*

## 6. Balance Sheet

The following is the estimated work distribution in the group for this implementation project.

| | Meriton Xhymshiti | Daniel Satcs | Ruben Govers | Sri Saai Akhheel Bandi |
|---|---|---|---|---|
| Color Refinement | 50% | – | – | 50% |
| Branching Algorithm | 25% | 25% | 25% | 25% |
| Fast Part. Refinement | – | 50% | 50% | – |

**Table 4:** *Work Distribution Group 09.*

## References

[1] Hopcroft J. (1971) An $n \log n$ algorithm for minimizing states in a finite automaton. In *Theory of machines and computations* (Proc. Internat. Sympos., Technion, Haifa, 1971), New York: Academic Press, 189-196.