Optimizing Software Product Line Architectures with OPLA-Tool

Édipo Luis Féderle[1] , Thiago do Nascimento Ferreira[1] , Thelma Elita Colanzi[2] , Silvia Regina Vergilio[1]

[1]DInf - Federal University of Paraná, Curitiba, Brazil

[2]DIN - State University of Maringá, Maringá, Brazil

edipofederle@gmail.com, {tnferreira, silvia}@inf.ufpr.br, thelma@din.uem.br

SSBSE'15

Introduction

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- The Product Line Architecture (PLA) is an important artifact that contains all the commonalities and variabilities of a Software Product Line (SPL).
- Colanzi et al. [2014] introduced MOA4PLA, a *Multi-objective Optimization Approach for PLA Design* where a set of PLA alternatives is produced, representing the best trade-off among objectives related to cohesion, coupling, and features modularization;
- A supporting tool is fundamental: practical use of MOA4PLA and to reduce efforts.

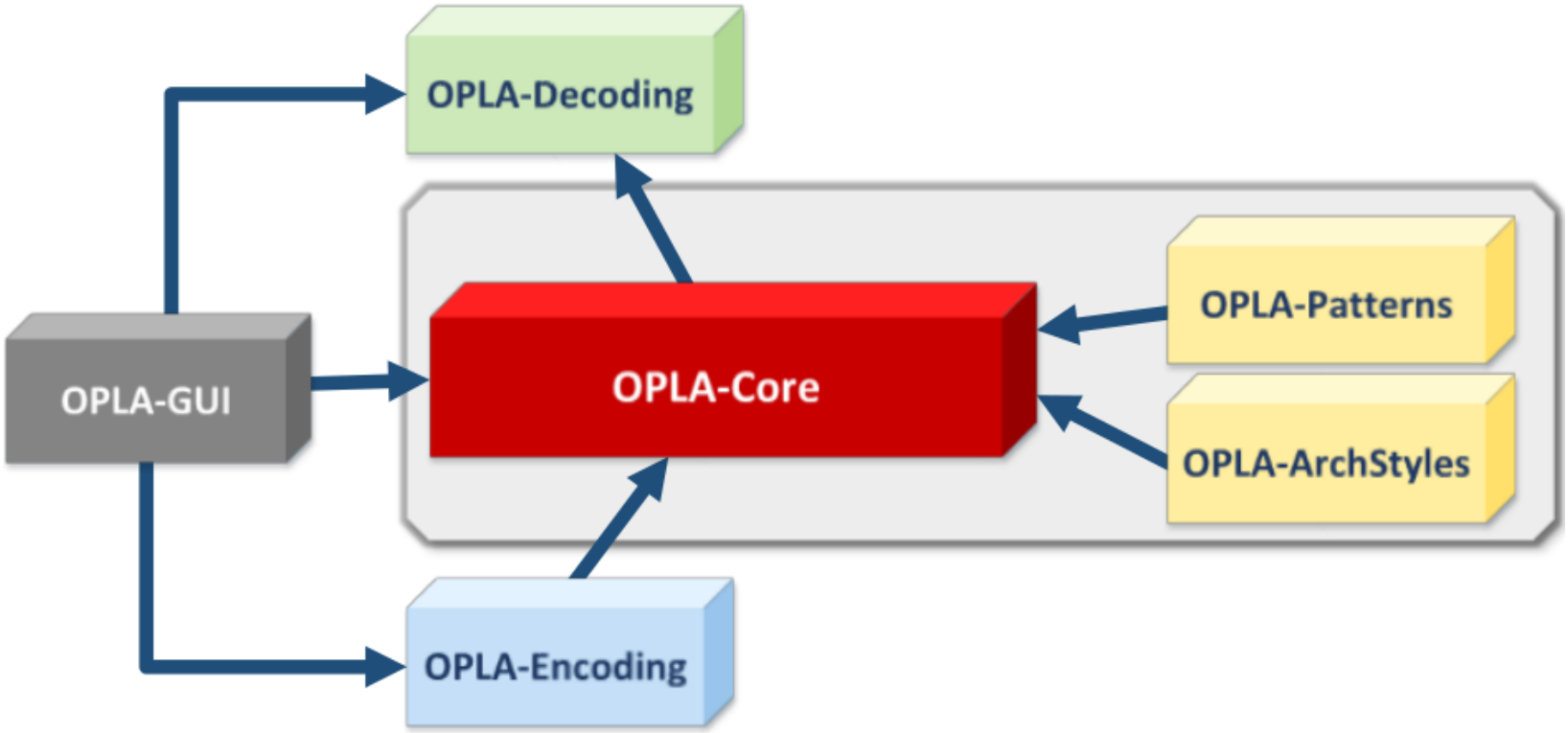
Introduction

- Motivation
  - Tools found in the literature such as **Darwin Tool** and **Dearthoir Tool** need adaptation to support MOA4PLA application and do not consider specific PLA characteristics.
- Goals:
  - This work describes OPLA-Tool (Optimization for PLA Tool) and presents an empirical study conducted in order to evaluate its usefulness by analysing the obtained solutions;

OPLA-Tool

OPLA-Tool

- OPLA-Tool implements the MOA4PLA process;
- Modules:

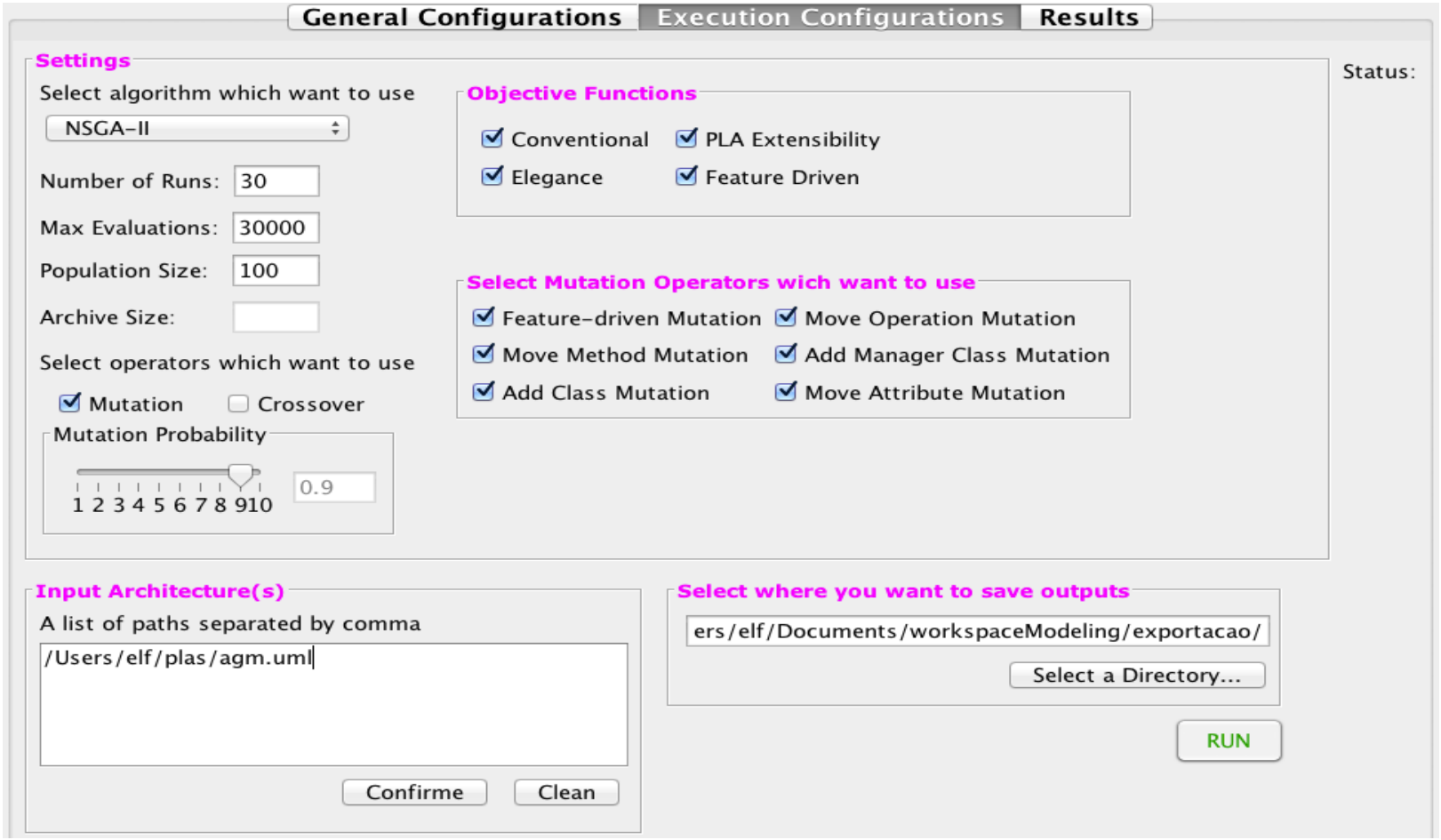


OPLA-Tool

- **OPLA-GUI** offers a graphical interface that allows the architect to select the input PLA, the algorithm parameters and operators;
- **OPLA-Encoding** receives as input a class diagram and creates to the representation used by the algorithm;
- **OPLA-Decoding** converts the representation used by the algorithm to a class diagram;
- **OPLA-Core** implements the Multi-Objective Algorithms such as NSGA-II and PAES;
- **OPLA-Patterns** and **OPLA-ArchStyles** implement search operators related, respectively to, design pattern application and use of architectural styles.

OPLA-Tool

- Execution Configurations Tab



Empirical Study

Empirical Study

- Goal:
  - To evaluate whether OPLA-Tool is useful to support the automated MOA4PLA application in PLA design optimization;
- Algorithms:
  - NSGA-II and PAES;
- Fitness Functions:
  - CM *(Indicator about cohesion, coupling and size)*
  - FM *(Feature Modularization)*
  - Ext *(Extensibility degree of SPL in terms of the PLA abstraction)*
- Used PLAs:
  - Arcade Game Maker (AGM);
  - Mobile Media (MM);
  - Electronics Tickets for Urban Transport (BET).

Empirical Study

- Parameters:
  - Evaluations: 30,000;
  - Population size: 100;
  - File (PAES): 100;
  - Mutation rate: 90%;
  - Runs: 30.
- PF_{known}: obtained from the found solutions of all runs of an algorithm, by eliminating duplicate and dominated ones.

Results

Results

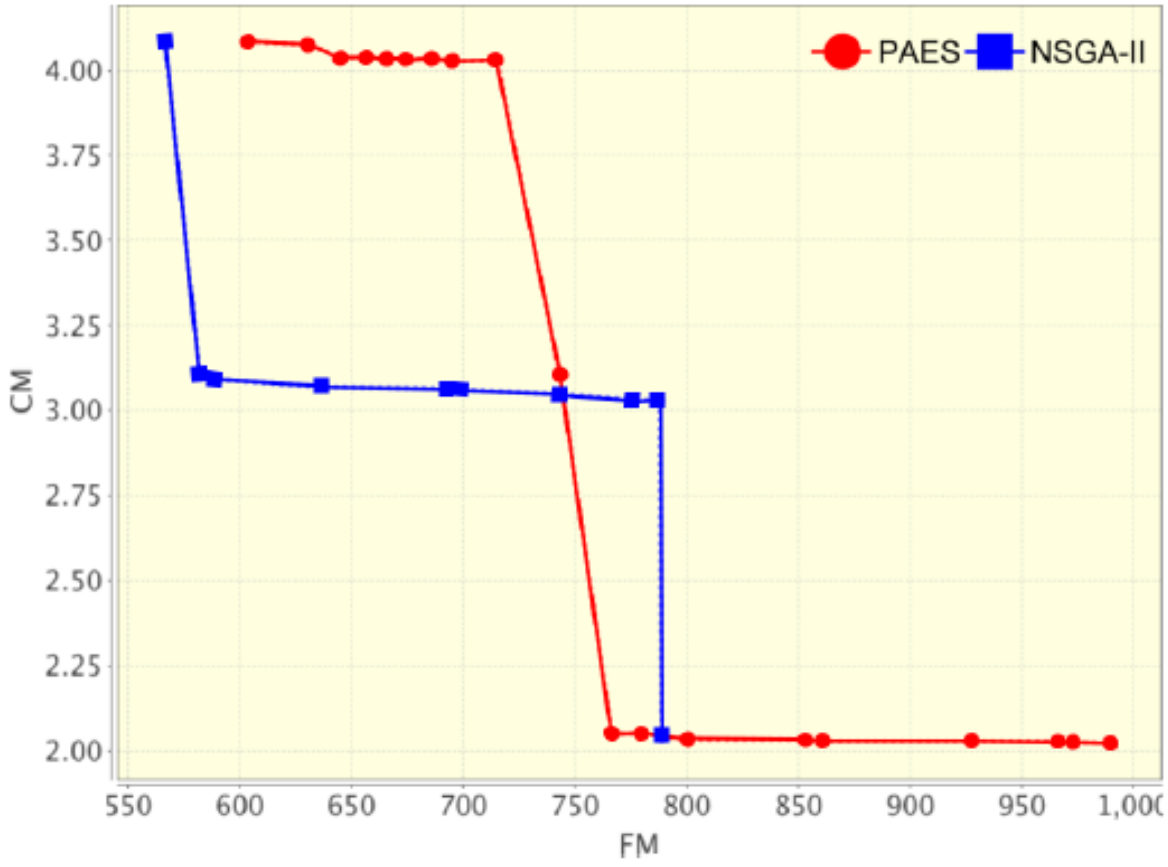
Table 1. Number of solutions and *hypervolume*

PLA	PF_k		*hypervolume*		*statistical test*	
	NSGA-II	PAES	NSGA-II	PAES	p-value	difference?
AGM	11	20	0.00477 ± 0.00167	0.00308 ± 0.00209	0.06788	no
MM	6	7	0.00347 ± 0.00132	0.00642 ± 0.00221	0.00348	yes
BET	18	23	$0.00652 \pm 08.0E\text{-}4$	$0.00813 \pm 3.6E\text{-}4$	4.3204E-8	yes

- For AGM there is no statistical difference
- PAES is the best for MM and BET in terms of hypervolume.

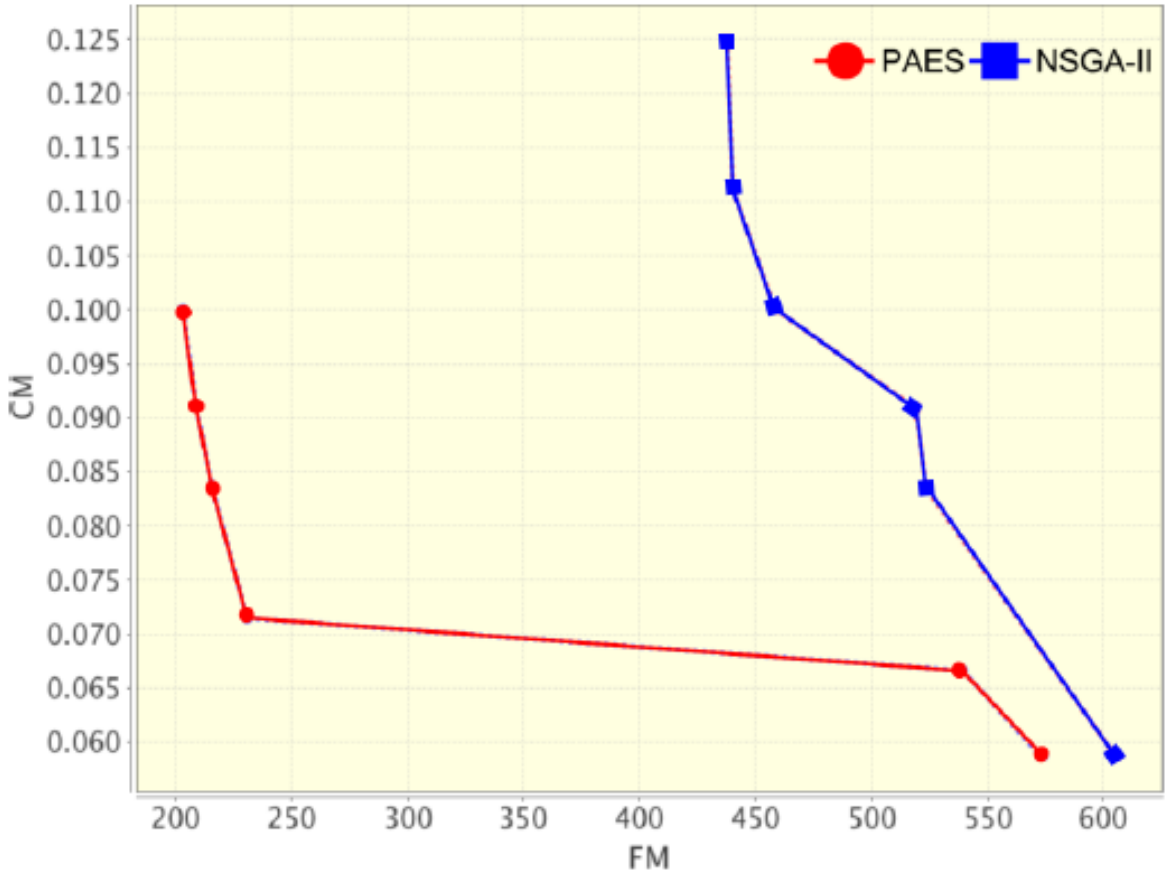
Results

- PLA AGM



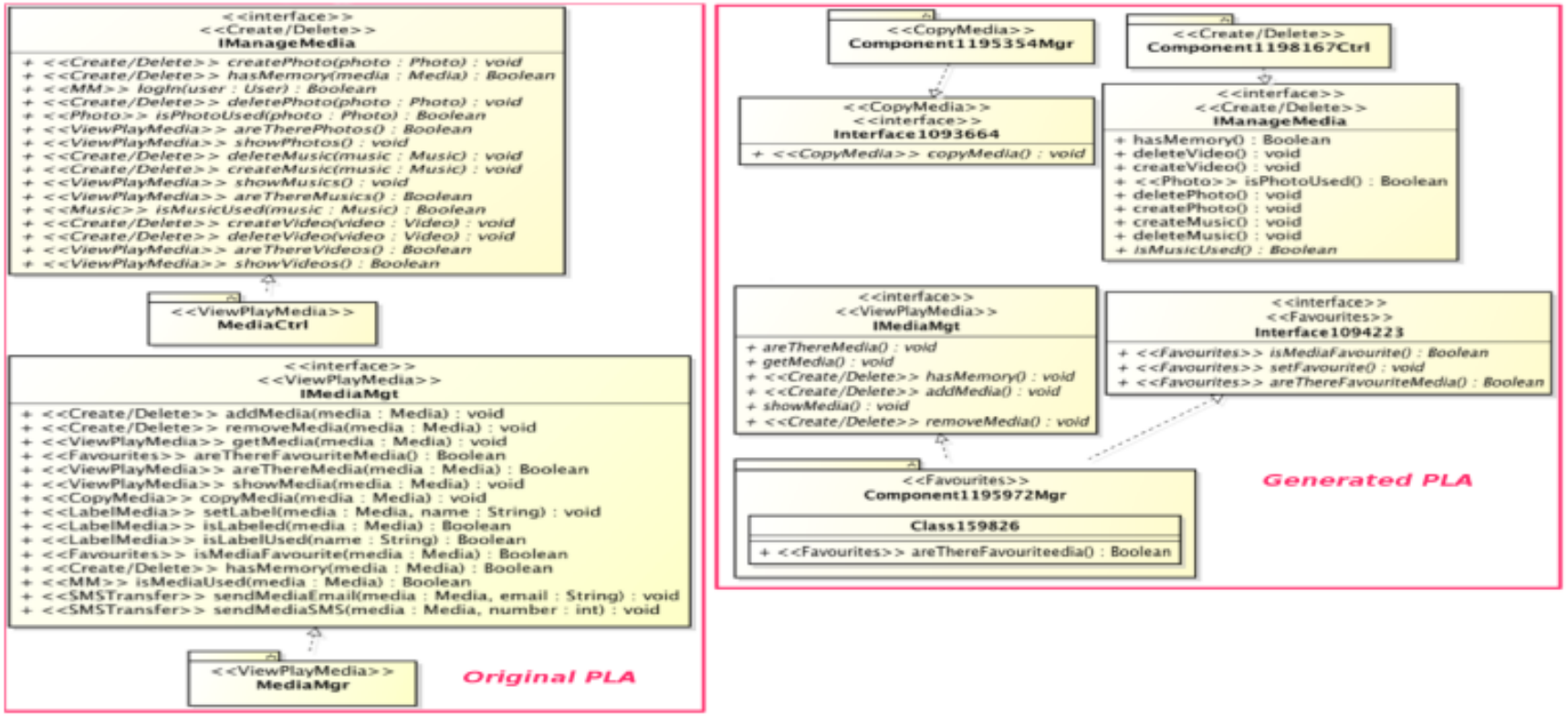
Results

- PLA MM



Results

- Generated Alternative PLA



Conclusion and Future Work

Conclusion

- This paper described OPLA-Tool for PLA optimization;
- Three PLAs and the algorithms NSGA-II and PAES were used;
- PAES presented the best hypervolume values for two PLAs, with statistical difference, and a greater number of solutions in most cases;
- Future work includes improvements in visualization of the solutions and implementation of new algorithms and objectives;
- More informations at:
  - **http://www.inf.ufpr.br/gres/opla-tool/**

Thanks!

http://www.inf.ufpr.br/gres