

## 2.3. EXAMPLES OF SELF-ADAPTIVE EVOLUTIONARY ALGORITHMS

Through this self-adaptation no input is needed for the parameter and the values are set by the algorithm itself. Each individual has its own  $\sigma$ . Another finer approach is to give each gene its own  $\sigma$  leading to the following representation:

$$\langle \sigma_1, p_1, \sigma_2, p_2, \dots, \sigma_n, p_n, \sigma_{n+1}, p_{n+1}, \dots, \sigma_k, p_k \rangle$$

In this form each gene gets its own step size and the individuals get a larger freedom grade in adapting itself to the shape of the fitness function.

What has to be noticed is that the adaptation of the parameter (the mutation step size here) happens before the fitness is given to it. That means that getting a good parameter doesn't rise the individual's fitness but only its performance over time.

*Self-adaptive parameter control encodes the parameter within each individual encoding it with the individual.*

## 2.3. Examples of self-adaptive Evolutionary Algorithms

In this part of this chapter I will describe some examples of self-adaptive evolutionary algorithms. The first section describes different approaches to self-adaptation where different operators are used. In the last section an example of a combination of different self-adapting parameters is given.

### 2.3.1 Self-adaptive Evolutionary Algorithms adapting one parameter

An interesting approach to a self-adaptive crossover operator in a genetic algorithm is found in [Spe95]. Spears decided to let the GA be self-selective with respect to its choice of crossover operation. He argues that as 2-point crossover is the least disruptive<sup>6</sup>, and uniform crossover the most disruptive operator, it is reasonable to have the GA select from only those two possibilities. Although a high disruption may stress exploration at the expense of exploitation, there are situations in which minimizing disruption hinders the adaptive search process by overemphasizing exploitation at the expense of needed exploration. An example of this is when the population size is too small to provide the necessary sampling accuracy for complex search spaces [JSS91].

The implementation appends one bit to the end of every individual in the GA population. This bit decides whether it is better to use uniform crossover or to use 2-point crossover. Also, since the approach is tightly coupled, all genetic operators are allowed to manipulate this extra bit (including crossover). There are two possibilities how to use this bit. *Local adaptation* uses this bit only for two individuals: if both bits are equal, the respective crossover is performed, if not, a random crossover is chosen. *Global adaptation* uses the last bits of the population to probabilistically determine which crossover operator

<sup>6</sup>The main motivation to let the algorithm decide.

# Selfadaptive Software

**Javier Cámara, Rogério de Lemos, Carlo  
Ghezzi, Antonia Lopes**

## Selfadaptive Software:

An Introduction to Self-adaptive Systems Danny Weyns, 2020-10-07 A concise and practical introduction to the foundations and engineering principles of self adaptation Though it has recently gained significant momentum the topic of self adaptation remains largely under addressed in academic and technical literature This book changes that Using a systematic and holistic approach An Introduction to Self adaptive Systems A Contemporary Software Engineering Perspective provides readers with an accessible set of basic principles engineering foundations and applications of self adaptation in software intensive systems It places self adaptation in the context of techniques like uncertainty management feedback control online reasoning and machine learning while acknowledging the growing consensus in the software engineering community that self adaptation will be a crucial enabling feature in tackling the challenges of new emerging and future systems The author combines cutting edge technical research with basic principles and real world insights to create a practical and strategically effective guide to self adaptation He includes features such as An analysis of the foundational engineering principles and applications of self adaptation in different domains including the Internet of Things cloud computing and cyber physical systems End of chapter exercises at four different levels of complexity and difficulty An accompanying author hosted website with slides selected exercises and solutions models and code Perfect for researchers students teachers industry leaders and practitioners in fields that directly or peripherally involve software engineering as well as those in academia involved in a class on self adaptivity this book belongs on the shelves of anyone with an interest in the future of software and its engineering *Software Engineering for Self-Adaptive Systems* Betty H. C. Cheng, Rogério de Lemos, Paola Inverardi, Jeff Magee, 2009-06-10 Although the self adaptability of systems has been studied in a wide range of disciplines from biology to robotics only recently has the software engineering community recognized its key role in enabling the development of future software systems that are able to self adapt to changes that may occur in the system its requirements or the environment in which it is deployed The 12 carefully reviewed papers included in this state of the art survey originate from the International Seminar on Software Engineering for Self Adaptive Systems held in Dagstuhl Castle Germany in January 2008 They examine the current state of the art in the field describing a wide range of approaches coming from different strands of software engineering and present future challenges facing this ever resurgent and challenging field of research Also included in this book is an invited roadmap paper on the research challenges facing self adaptive systems within the area of software engineering based on discussions at the Dagstuhl Seminar and put together by several of its participants The papers have been divided into topical sections on architecture based self adaptation context aware and model driven self adaptation and self healing These are preceded by three research roadmap papers Software Engineering for Self-adaptive Systems ,2009 Although the self adaptability of systems has been studied in a wide range of disciplines from biology to robotics only recently has the software engineering community recognised its key role in enabling

the development of future software systems that are able to self adapt to changes that may occur in the system its requirements or the environment in which it is deployed The 12 carefully reviewed papers included in this state of the art survey originate from the International Seminar on Software Engineering for Self Adaptive Systems held in Dagstuhl Castle Germany in January 2008 They examine the current state of the art in the field describing a wide range of approaches coming from different strands of software engineering and present future challenges facing this ever resurgent and challenging field of research Also included in this book is an invited roadmap paper on the research challenges facing self adaptive systems within the area of software engineering based on discussions at the Dagstuhl Seminar and put together by several of its participants The papers have been divided into topical sections on architecture based self adaptation context aware and model driven self adaptation and self healing These are preceded by three research roadmap papers

**Software Engineering for Self-Adaptive Systems II**, 2013-01-12 Software Engineering for Self-Adaptive Systems Rogério de Lemos, Holger Giese, Hausi A. Müller, Mary Shaw, 2013-01-03 Although the self adaptability of systems has been studied in a wide range of disciplines from biology to robotics only recently has the software engineering community recognized its key role in enabling the development of self adaptive systems that are able to adapt to internal faults changing requirements and evolving environments The 15 carefully reviewed papers included in this state of the art survey were presented at the International Seminar on Software Engineering for Self Adaptive Systems held in Dagstuhl Castle Germany in October 2010 Continuing the course of the first book of the series on Software Engineering for Self Adaptive Systems the collection of papers in this second volume comprises a research roadmap accompanied by four elaborating working group papers Next there are two parts with three papers each entitled Requirements and Policies and Design Issues part four of the book contains four papers covering a wide range of Applications

Self-Adaptive Software Paul Robertson, Howie Shrobe, Robert Laddaga, 2003-05-15 Self adaptive software evaluates its own behavior and changes its behavior when the evaluation indicates that the software does not accomplish what it is intended to do or when better functionality or better performance is possible The self adaptive approach in software engineering builds on well known features like the use of errors and the handling of exceptions in languages like Lisp or Java and aims at improving the robustness of software systems by gradually adding new features of self adaption and autonomy This book originates from the First International Workshop on Self Adaptive Software IWSAS 2000 held in Oxford UK in April 2000 The revised full papers presented in the volume together with an introductory survey by the volume editors assess the state of the art in this emerging new field and set the scene for future research and development work

**Self-Adaptive Software** Robert Laddaga, Paul Robertson, Howard E. Shrobe, 2003-02-21 The 18 revised full papers presented in this book together with an introductory survey were carefully reviewed and constitute the documentation of the Second International Workshop on Self adaptive Software IWSAS 2001 held in Balatonfured Hungary in May 2001 Self adaptive software evaluates its own behavior and changes it when the

evaluation indicates that the software does not accomplish what it is intended to do or when better functionality or better performance is possible The self adaptive approach in software engineering builds on well known dynamic features familiar to Lisp or Java programmes and aims at improving the robustness of software systems by gradually adding new features of self adaption or autonomy Software Engineering for Self-Adaptive Systems III. Assurances Rogério de Lemos, David Garlan, Carlo Ghezzi, Holger Giese, 2018-01-16 A major challenge for modern software systems is to become more cost effective while being versatile flexible resilient energy efficient customizable and configurable when reacting to run time changes that may occur within the system itself its environment or requirements One of the most promising approaches to achieving such properties is to equip the software system with self adaptation capabilities Despite recent advances in this area one key aspect that remains to be tackled in depth is the provision of assurances Originating from a Dagstuhl seminar held in December 2013 this book constitutes the third volume in the series Software Engineering for Self Adaptive Systems and looks specifically into the provision of assurances Opening with an overview chapter on Research Challenges the book presents 13 further chapters written and carefully reviewed by internationally leading researchers in the field The book is divided into topical sections on research challenges evaluation integration and coordination and reference architectures and platforms **Self-Adaptive Software** Paul Robertson, Howie Shrobe, Robert Laddaga, 2001-01-30 Self adaptive software evaluates its own behavior and changes its behavior when the evaluation indicates that the software does not accomplish what it is intended to do or when better functionality or better performance is possible The self adaptive approach in software engineering builds on well known features like the use of errors and the handling of exceptions in languages like Lisp or Java and aims at improving the robustness of software systems by gradually adding new features of self adaption and autonomy This book originates from the First International Workshop on Self Adaptive Software IWSAS 2000 held in Oxford UK in April 2000 The revised full papers presented in the volume together with an introductory survey by the volume editors assess the state of the art in this emerging new field and set the scene for future research and development work

Engineering Adaptive Software Systems Yijun Yu, Arosha Bandara, Shinichi Honiden, Zhenjiang Hu, Tetsuo Tamai, Hausi Muller, John Mylopoulos, Bashar Nuseibeh, 2019-01-14 This book discusses the problems and challenges in the interdisciplinary research field of self adaptive software systems Modern society is increasingly filled with software intensive systems which are required to operate in more and more dynamic and uncertain environments These systems must monitor and control their environment while adapting to meet the requirements at runtime This book provides promising approaches and research methods in software engineering system engineering and related fields to address the challenges in engineering the next generation adaptive software systems The contents of the book range from design and engineering principles Chap 1 to control theoretic solutions Chap 2 and bidirectional transformations Chap 3 which can be seen as promising ways to implement the functional requirements of self adaptive systems Important quality requirements are also

dealt with by these approaches parallel adaptation for performance Chap 4 self adaptive authorization infrastructure for security Chap 5 and self adaptive risk assessment for self protection Chap 6 Finally Chap 7 provides a concrete self adaptive robotics operating system as a testbed for self adaptive systems The book grew out of a series of the Shonan Meetings on this ambitious topic held in 2012 2013 and 2015 The authors were active participants in the meetings and have brought in interesting points of view After several years of reflection they now have been able to crystalize the ideas contained herein and collaboratively pave the way for solving some aspects of the research problems As a result the book stands as a milestone to initiate further progress in this promising interdisciplinary research field

*Self-adaptive Software* Robert Laddaga, Paul L. Robertson, IWSAS., *Self-adaptive Software*, 2001

**Self-Adaptive Software** Paul Robertson, Howie Shrobe, Robert Laddaga, 2003-05-15 Self adaptive software evaluates its own behavior and changes its behavior when the evaluation indicates that the software does not accomplish what it is intended to do or when better functionality or better performance is possible The self adaptive approach in software engineering builds on well known features like the use of errors and the handling of exceptions in languages like Lisp or Java and aims at improving the robustness of software systems by gradually adding new features of self adaption and autonomy This book originates from the First International Workshop on Self Adaptive Software IWSAS 2000 held in Oxford UK in April 2000 The revised full papers presented in the volume together with an introductory survey by the volume editors assess the state of the art in this emerging new field and set the scene for future research and development work

**Evolving Software Systems for Self-adaptation** Mehdi Amoui Kalareh, 2012 There is a strong synergy between the concepts of evolution and adaptation in software engineering software adaptation refers to both the current software being adapted and to the evolution process that leads to the new adapted software Evolution changes for the purpose of adaptation are usually made at development or compile time and are meant to handle predictable situations in the form of software change requests On the other hand software may also change and adapt itself based on the changes in its environment Such adaptive changes are usually dynamic and are suitable for dealing with unpredictable or temporary changes in the software's operating environment A promising solution for software adaptation is to develop self adaptive software systems that can manage changes dynamically at runtime in a rapid and reliable way One of the main advantages of self adaptive software is its ability to manage the complexity that stems from highly dynamic and nondeterministic operating environments If a self adaptive software system has been engineered and used properly it can greatly improve the cost effectiveness of software change through its lifespan However in practice many of the existing approaches towards self adaptive software are rather expensive and may increase the overall system complexity as well as subsequent future maintenance costs This means that in many cases self adaptive software is not a good solution because its development and maintenance costs are not paid off The situation is even worse in the case of making current legacy systems adaptive There are several factors that have an impact on the cost effectiveness and usability of self adaptive software

however the main objective of this thesis is to make a software system adaptive in a cost effective way while keeping the target adaptive software generic usable and evolvable so as to support future changes

Assurances for Self-Adaptive Systems Javier Cámara,Rogério de Lemos,Carlo Ghezzi,Antonia Lopes,2013-01-16 The increasing complexity of systems and the growing uncertainty in their operational environments have created a critical need to develop systems able to improve their operation adapt to change and recover from failures autonomously This situation has led to recent advances in self adaptive systems able to reconfigure their structure and modify their behavior at run time to adapt to environmental changes Despite these advances one key aspect of self adaptive systems that remains to be tackled in depth is assurances the provision of evidence that the system satisfies its stated functional and non functional requirements during its operation in the presence of self adaptation This book is one of the outcomes of the ESEC FSE 2011 Workshop on Assurances for Self Adaptive Systems ASAS held in Szeged Hungary in September 2011 It contains extended versions of some of the papers presented during the workshop as well as invited papers from recognized experts The 12 refereed papers were thoroughly reviewed and selected The book consists of four parts formal verification models and middleware failure prediction and assurance techniques

**Self-Adaptive Software** Robert Laddaga,Paul Robertson,Howie Shrobe,2014-03-12 The 18 revised full papers presented in this book together with an introductory survey were carefully reviewed and constitute the documentation of the Second International Workshop on Self adaptive Software IWSAS 2001 held in Balatonf red Hungary in May 2001 Self adaptive software evaluates its own behavior and changes it when the evaluation indicates that the software does not accomplish what it is intended to do or when better functionality or better performance is possible The self adaptive approach in software engineering builds on well known dynamic features familiar to Lisp or Java programmes and aims at improving the robustness of software systems by gradually adding new features of self adaption or autonomy

A *Quality-Driven Approach to Enable Decision-Making in Self-Adaptive Software* Mazeiar Salehie,2010

Self-adaptive Software ,2000

*Self-Adaptive Software* Paul Robertson,Howie Shrobe,Robert Laddaga,2001-01-30 Self adaptive software evaluates its own behavior and changes its behavior when the evaluation indicates that the software does not accomplish what it is intended to do or when better functionality or better performance is possible The self adaptive approach in software engineering builds on well known features like the use of errors and the handling of exceptions in languages like Lisp or Java and aims at improving the robustness of software systems by gradually adding new features of self adaption and autonomy This book originates from the First International Workshop on Self Adaptive Software IWSAS 2000 held in Oxford UK in April 2000 The revised full papers presented in the volume together with an introductory survey by the volume editors assess the state of the art in this emerging new field and set the scene for future research and development work

Dynamic Generation of Adaptation Plans for Self-adaptive Software Systems Carlos Eduardo da Silva,2011

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