Learning Java Programming in Clara's World

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With gratitude to our families
for encouraging us to complete this work
and providing comfort and support,
while receiving much less attention than they deserve.

Preface

Welcome to *Learning Java Programming in Clara's World*. This book is intended for a one-semester university or an equivalent high school programming course. It is equally suitable for just about anyone else who wants to start learning programming. While this text is written for students with little or no prior programming experience, experienced programmers would also benefit from the in-depth explanations, visual teaching style of this book and interesting programming challenges supplied with it.

Why Did We Write This Book?

The story of this book began ten years ago from overhearing a group of computer science students loudly talking about how much they hate programming. Hearing something like this while being deeply in love with programming made a significant impact on us and resulted in a strong feeling that something had to be done about this. Back then we were two young university academics with background in video games development and virtual reality with no involvement or experience in teaching programming. Programming was our passion and the key instrument in our daily lives. We felt a strong urge to share this passion and explain why programming is such an important tool in the twenty-first century.

After months of research into motivational techniques and existing novel methods of teaching programming, we have produced a proposal for teaching programming fundamentals that relied on similar principles (such as flow [1]) that game developers use for making players attracted to their games. We are grateful to our dean, Simeon Simoff, for trusting our passion and expertise and for allowing us to implement this proposal at Western Sydney University. Five years later, we received two national and one international awards for the teaching methodology and the visual programming framework that forms the basis for this book. The most important achievement, however, is that we have not heard students expressing their hate of programming ever since we started teaching it at our university.

Teaching Programming in a Fun Way

In this book, we are introducing the key fundamental concepts of Java programming such as loops, conditional statements, variables, expressions, methods and arrays through the eyes of a small ladybug called Clara. Clara is a fun and extremely obedient insect, who initially has very limited intelligence. Readers learn programming by making Clara move around and manipulate objects in her world. As the book progresses, Clara becomes smarter and smarter and develops her sense of touch and vision. She progressively acquires new programming skills and (together with readers) learns by tackling some of the world's greatest challenges.

Unlike many other programming textbooks that rely on solving toy artificial problems, this book explains programming concepts through real-world problems such as developing a vacuum cleaner robot, automatically patching potholes, launching rockets into space, simulating projectile motion, dynamically avoiding obstacles, delivering mail, etc. Every chapter of the book starts by presenting a challenge and then continues to explain new programming concepts with the focus on tackling this challenge. Focusing the new material explanation on these challenges helps to remind the readers of how this material is connected with the problems that they may encounter in the real world and makes it easier to relate to.

Our Teaching Approach

In order to develop the teaching methodology for this book we have reviewed and partially borrowed some of the best teaching metaphors and approaches from programming courses such as SwissEduc's "Informatik" [2] and Stanford's "Programming Methodology Course" [3] . We utilised concepts from motivational psychology [1] and applied techniques from gamification of education [4] and utilised relevant game design principles [5] to ensure that we can maintain a high level of student interest while working with programming exercises.

Our book relies on a visual teaching framework called "Clara's World". This framework uses similar principles of teaching programming in a visual way to those employed by introductory programming learning tools such as Karel [6], Scratch [7], Greenfoot [8] and Code.org [9]. Most existing frameworks and tools (i.e. Code.org and Scratch) have been developed with primary school students in mind. Our framework, however, targets university and high school students. Some frameworks (such as Greenfoot) are suitable for high school students, but they require students to memorise a large number of framework-specific commands, while in Clara's World the number of additional commands is very small, so students can concentrate on learning Java. Karel is probably the most suitable piece of software for the high school and university context, but it is underdeveloped. This is why Karel is usually employed in the first couple of introductory lectures, after which students have to switch to one of the traditional Java frameworks and abandon the highly visual approach of Karel. In contrast to Karel, this book in combination with

Clara's World helps to complete the entire first semester of a university programming fundamentals course without abandoning the visual teaching style, while allowing to maintain the required level of depth and complexity of explaining the key programming concepts.

The emphasis in this book is on making readers understand the very basic control structures that are common to all programming languages rather than immediately diving into the complexity of working with classes and objects as many other books do. The text gradually introduces readers to conditional statements, loops, methods, variables and arrays and then provides a quick overview of classes and objects towards the end. With the help of this book you will understand foundations of programming that are common for most modern programming languages, with a specific emphasis on Java (one the most in-demand languages on the market today).

We hope you enjoy learning Java in Clara's World and become as passionate about programming as we are.

Additional Online Resources

This book is supplied with digital online resources for students and educators. All programming problems presented in this book can be explored on the Clara's World website at `https://claraworld.net`.

Every programming problem covered in this book has a corresponding link to a problem template (for those readers willing to attempt the problem themselves), the link to the solution of this problem and a video recording of us solving this problem step-by-step. In addition, at the end of each chapter there is a link to exercises that readers are recommended to complete.

Instructors can be provided with a wide range of educational resources after proving their instructor status.

Digital Resources for Readers and Educators

This textbook provides free unrestricted access to online digital resources. These resources include templates and solutions for all problems presented in the book, as well as additional exercises for self study.

Students and other book readers should follow the instructions below to register on the Clara's World website and access these resources.

1. Go to `https://www.claraworld.net`
2. Select "Enter Clara's World"
3. Click "Register" and follow the on-screen instructions
4. Enter your registration details and make sure that you provide a valid email address
5. Select "Book" as the Organisation
6. Type "book2021" (without quotation marks) in the "Organisation Password" field
7. Check your inbox for the supplied email address and complete registration following the instructions you receive via email
8. Sign in with your email address and password and start using digital resources[1]

Educators can be granted access to additional resources such as lecture slides, educational videos, a large pool of exercises for every topic covered in the book, the content management and marking system, automatic plagiarism detection of submitted code and other specialised tools, facilities for registering your organisation on Clara's World, facilities for setting up your own teaching resources and exercises, admin access to your organisation, video tutorials for educators and much more.

If you are interested in using Clara's World for your programming course as an educator please send us an introductory email to educator@claraworld.net, so that we can verify your educator status.

[1] See Appendix A for further information about creating an account on Clara's World and using the digital resources.

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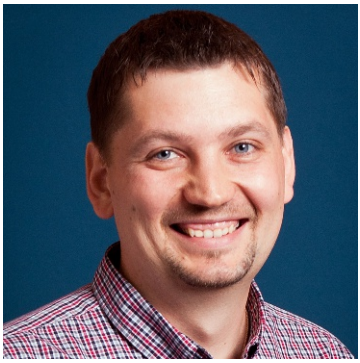
About the Authors



Dr Anton Bogdanovych is a senior lecturer of entertainment computing and applied artificial intelligence at Western Sydney University, School of Computer, Data and Mathematical Sciences.

He has worked at Western Sydney University since 2007 and currently teaches "Video Game Development" and "Programming Fundamentals".

Anton's innovative approach to teaching programming fundamentals (that laid the foundations of this book) has been recognised on a national and international level. Dr Bogdanovych has been awarded the **ICT Higher Education Educator of the Year 2015** by the Australian Computer Society (ACS) and received the **International ICT Educator of the Year 2016 Award** by The South East Asia Regional Computer Confederation (SEARCC).

Since 2017 Anton Bogdanovych has been the director of academic program for the Bachelor of Entrepreneurship degree at Western Sydney University.

Anton completed his PhD in Computer Science at the University of Technology Sydney in May 2008. He is currently involved in a number of research projects related to virtual reality, artificial intelligence, robotics and motion capture.

Before starting his PhD, Dr Bogdanovych worked as a researcher and software developer in the Multiagent Systems Department in the German Research Centre for Artificial Intelligence (DFKI). The DFKI is one of the largest and most prestigious artificial intelligence research centres in the world.

Anton's industry experience with Software MacKiev (one the largest companies that produces Macintosh versions of famous Windows titles) has helped him to get familiar with programming methodologies, tools and people management techniques employed for producing large-scale commercial software. One of his products (WorldBook Encyclopedia) was preinstalled on every iMac computer sold in 2001.

Dr. Tomas Trescak holds a PhD in computer science with a specialisation in artificial intelligence from the Artificial Intelligence Research Institute, Barcelona, Spain (IIIA) of the Spanish Research Council (CSIC). For the past seven years he has worked as a senior lecturer of intelligent systems at Western Sydney University. Since 2020, Tomas has acted as a director of academic program for undergraduate studies in information and communication technology (ICT).

Tomas is an avid open-source enthusiast, contributing to existing software initiatives. He has published over 50 open-source packages for back-end and front-end development, as well as many software tools for virtual and augmented realities.

Tomas is the creator of the Clara's World framework that we utilise in this book. For his academic and software development work, Tomas has received multiple awards, among which are the **2016 Best Innovator Award** by Unearthed Association and **2015 Gold Disruptor Award** in the Best Australian ICT Educator category by the Australian Computer Society.

In his academic work Tomas seeks new ways to facilitate complex cognitive tasks in simulation, education, healthcare, cyber security and social sciences through the application of artificial intelligence. The primary focus of his research is on facilitation of creation and execution of self-adaptable, interactive normative 3D environments and their subsequent application to the fields of agent-based simulation, as well as virtual and augmented realities.