

UNIVERSITY OF MILAN

Public selection for recruiting No. 1 research associate(s) under art.24, paragraph 3.a, of Law No.240/2010 for competition sector 01/B1 - Informatics, (scientific-disciplinary sector INF/01 - Informatics) at the Department of Computer Science, (announcement published in Official Gazette No. 87 of 02 November 2021) - Competition code 4919

Luca Prigioniero

CURRICULUM VITAE

PERSONAL DATA

SURNAME	PRIGIONIERO
NAME	LUCA
DATE OF BIRTH	16/02/1992

QUALIFICATIONS**DEGREE**

- Undergraduate Degree in Computer Science at Università degli Studi di Milano (2014)
- Master Degree in Computer Science at Università degli Studi di Milano (2016)

DOCTORAL DEGREE OR EQUIVALENT QUALIFICATION EARNED IN ITALY OR ABROAD / MEDICAL SPECIALISATION DIPLOMA OR EQUIVALENT QUALIFICATION, FOR THE RELEVANT SECTORS, EARNED IN ITALY OR ABROAD

PhD in Computer Science at Università degli Studi di Milano (2020)

RESEARCH CONTRACTS, RESEARCH FELLOWSHIP CONTRACTS, POSTDOCTORAL SCHOLARSHIPS OR SIMILAR CONTRACTS

Research Fellowship at Justus Liebig University Giessen (October 2019 - February 2020)
Postdoctoral Scholarship at Università degli Studi di Milano (March 2020 - February 2022)

ATTESTED TRAINING OR RESEARCH ACTIVITIES AT QUALIFIED ITALIAN OR FOREIGN INSTITUTIONS**Short-term scientific missions:**

- Justus Liebig University Giessen, December 2017 - Supported by *COST Action IC1405 - Grant n. 38564*
- University of Copenhagen, October 2018 - Supported by *COST Action IC1405 - Grant n. 41983*

Attendance to summer schools:

- *International training school on reversible computation*, Toruń, August 2017 - Supported by *COST Action IC1405*
- *LIPA summer school*, Warsaw, June 2018 - Partially supported by the ERC Consolidator grant agreement n. 683080

Internship at University of Saskatchewan from February to July 2019

TEACHING ACTIVITIES AT ITALIAN OR FOREIGN UNIVERSITIES

Professore a contratto (Università degli Studi di Milano):

- 2019/2020 and 2020/2021 - Teoria dei Linguaggi (Laurea Magistrale in Informatica) - 30h per academic year

Teaching assistant (Università degli Studi di Milano):

- 2014/2015, 2015/2016, 2016/2017, and 2017/2018 - Laboratorio di Programmazione (Laurea Triennale in Informatica Musicale and Laurea Triennale in Comunicazione Digitale) with Dr. Massimo Santini and Prof. Sebastiano Vigna - 48h per course per academic year

- 2014/2015 and 2015/2016 - Laboratorio di Algoritmi e Strutture Dati (Laurea Triennale in Informatica) with Dr. Violetta Lonati - 48h per academic year

- 2015/2016 - Laboratorio di Ingegneria del Software (Laurea Triennale in Informatica) with Dr. Massimo Santini - 48h

- 2020/2021, 2021/2022 - Esercitazioni di Programmazione II (Laurea Triennale in Informatica) with Dr. Massimo Santini - 24h per academic year

- 2020/2021, 2021/2022 - Esercitazioni di Programmazione II (Laurea Triennale in Matematica) with Prof. Matteo Re' - 24h

RESEARCH PROJECTS

- PSR 2016 - "Reversibilità e parsabilità locale di linguaggi formali e automi: studio di proprietà teoriche e potenzialità applicative" (resp. Dr. Violetta Lonati)

- PSR 2016, 2017, 2018 - "Aspetti algebrici e computazionali nella logica e nelle sue applicazioni" (resp. Prof. Stefano Aguzzoli)

- PSR 2019, 2020 - "Logic and formal investigations of new models of computation" (resp. Prof. Stefano Aguzzoli)

ORGANISATION, SUPERVISION AND COORDINATION OF NATIONAL AND INTERNATIONAL RESEARCH GROUPS, OR PARTICIPATION IN THEM

2019-2021 - Member of INdAM (Istituto Nazionale di Alta Matematica) within the GNCS group (Gruppo Nazionale per il Calcolo Scientifico)

SPEAKING AT NATIONAL AND INTERNATIONAL CONFERENCES AND CONVENTIONS

Date	Title	Venue
06/2017	Concise Representations of Reversible Automata [C3]	DCFS 2017
08/2017	Non-Self-Embedding Grammars and Descriptive Complexity [C5]	NCMA 2017
09/2017	Weakly and Strongly Irreversible Regular Languages [C6]	AFL 2017
07/2018	Linear-Time Limited Automata [C7]	DCFS 2018
09/2018	Reversible Pushdown Transducers [C9]	DLT 2018
09/2018	Linear-Time Limited Automata [C12]	ICTCS 2018
09/2018	On Some Succinct Representations of Regular Languages [C11]	ICTCS 2018
07/2019	Pushdown Automata and Constant Height: Decidability and Bounds [C13]	DCFS 2019
09/2019	Reversible and Irreversible Languages: An Overview	RPLA 2019
09/2019	Pushdown Automata and Constant Height: An Overview [C14]	ICTCS 2019
07/2021	Invited talk - <i>Regular Languages: To Finite Automata and Beyond</i> [C16]	AUTOMATA 2021

07/2021	Boolean Kernels of Context-Free Languages [C17]	CIAA 2021
08/2021	Space Complexity of Stack Automata Models [C15]	DLT 2021

NATIONAL AND INTERNATIONAL AWARDS AND ACCOLADES FOR RESEARCH ACTIVITY

Conference DLT 2018 - Golden Student Travel Award - The University of Electro-Communications - Tokyo

OTHER INFORMATION

Member of the Program Committee of the conference DCFS 2019

Peer reviewing for the following conferences: AFL 2017, DCFS 2017, 2019, and 2020, DLT 2017, 2018, 2020, and 2021, ICALP 2017, NCMA 2018 and 2019, SOFSEM 2019 and 2020, UCNC 2019

Peer reviewing for the following journals: Acta Informatica, Annals of Mathematics and Artificial Intelligence, International Journal of Foundations of Computer Science, Theoretical Computer Science

Co-advising (undergraduate thesis):

Riccardo Bianchi - *Unary Automata in Chrobak Normal Form*

Andrea Rovati - *Automata 1-Limited: uno studio su linguaggi unari*

Conference attendance: AFL 2017, CIAA 2018, DCFS 2016, 2017 and 2018, DLT 2017 and 2018, NCMA 2017

Member of the organizing committee of the conferences MFCS 2015 and DCFS 2017

Invited speaker at the conference AUTOMATA 2021

RESEARCH ACTIVITY (Short Description)

The research activity of Luca Prigioniero is devoted to the investigation of computational models and their fundamental aspects. In this area, he is mainly focused on two aspects: concise descriptions of formal systems and reversibility of computational models.

Descriptive complexity of formal systems

Descriptive complexity is a branch of theoretical computer science whose goal is the investigation of the relationship between the sizes of the representations of formal systems that share the same computational power, or, in other words, the study of how concisely a system can describe a class of problems (or languages). A classical example in this area is the relationship between the size of deterministic and nondeterministic devices. It is well known that, for finite automata, the nondeterminism does not add computational power. However, the elimination of nondeterminism yields devices whose sizes are exponential in those of the original ones. Furthermore, in the worst case, this gap cannot be reduced. It is also known that the capability of moving the input head back and forth along the tape does not change the recognizing power of this model, also known as *two-way automata*. Nevertheless, the question about the cost of the elimination of the nondeterminism from two-way automata, raised by Sakoda and Sipser in 1978, is still open.

It is worth pointing out that the interests in this area are neither restricted to formal language and automata theory community only, nor purely theoretical. In fact, on the one hand, as shown by Sakoda and Sipser, their question about the cost of the elimination of the nondeterminism from finite automata by using the two-way motion is related to the P vs. NP question. On the other hand, the results in this area have direct consequences on the minimization of the size of circuits and on the compression of programs that formal computation devices may describe.

Part of the research activity of Luca Prigioniero focuses on computational models characterizing the class of regular languages and having succinct descriptions. In particular, generative models (non-self-embedding grammars) and recognizing devices (restrictions of Turing machines and pushdown automata) have been considered, and their relationships with finite automata in terms of computational and descriptive power have been proved.

Non-self-embedding grammars are a restriction of context-free grammars which does not allow to describe recursive structures. A double exponential gap in size from non-self-embedding grammars to

deterministic finite automata has been proven [J6]. Furthermore, non-self-embedding grammars are polynomially related in size to pushdown automata with a fixed pushdown size, and a polynomial simulation of these two models by Turing machines with restricted rewriting capabilities (“limited automata”) has been given [J5].

An exponential gap between the size of limited automata accepting regular languages and the size of equivalent finite automata was known. It has been shown that the same gap holds even in the unary case [J2].

In [J4] the time complexity of limited automata is investigated from a descriptiveness point of view. It has been shown that, with a polynomial increase in size and preserving determinism, each limited automaton recognizing a regular language can be transformed into an halting equivalent one that works in linear time. Also polynomial transformations into related models, including nondeterministic Turing machines working in linear time, and exponential gaps for converse transformations in the deterministic case have been studied and the costs, in terms of description sizes, of the conversion of nondeterministic finite automata into equivalent linear-time deterministic machines have been deepened [C10]. This study contributes to the investigation about the famous question posed by Sakoda and Sipser in 1978, concerning the size blowups from nondeterministic finite automata to two-way deterministic finite automata.

Moreover, he studied pushdown automata that accept their inputs by using a constant amount of the pushdown store, with respect to the input length, and the relationships between the size of these models and the amount of memory they use. It has also been proved that, in the general case, it cannot be decided whether or not a pushdown automaton accepts using constant pushdown height, while this problem turns to be decidable in the unary case [C13].

From February to July 2019 he has been at University of Saskatchewan as a Visiting Research Student. There, his research has been focused on the investigation of time and space complexity of Turing Machines operating under some restrictions [J7], and from October 2019 he joined the University of Gießen as Research Fellow, where he studied sub-families of context-free languages closed under Boolean operations [C17].

Reversibility of computational models

In the study of computations, reversibility means that each elementary step can be inverted. In other words, at any instant one can inverse the process thus recovering the previous configurations. As shown by Landauer in 1961, irreversibility in computation leads to heat dissipation, while Toffoli proved that it is ideally possible to build sequential circuits with zero internal power dissipation. This observation suggested to study reversible computations and computer architectures in which there is no loss of information. For example, a lot of work has been done in order to obtain a fully reversible computing system, in which each of its layers is reversible, from logic and circuit-design level to programs.

The main drawback of reversible systems is that they may have to compute operations that are, by nature, not invertible. For example, starting from the output of the logic operations *and* and *or* it is not always possible to determine which the input was. An intuitive and rudimentary solution to this problem is that of carrying some information about the input along with the output. Such a solution results in generation of “garbage” information, and so to the increase of the space used by the device. As a consequence, one of the goal in this area, is the minimization of the space used by these systems to recover their previous configurations.

Luca Prigioniero studies reversible formal models and their computations. In particular, the study of reversible deterministic automata have been deepened, and a characterization of regular languages that are accepted by multiple minimal non-isomorphic reversible automata has been obtained [J1]. The investigations about reversible deterministic automata have been extended and succinct representations of such a model have been obtained [J3]. Using those representations it is possible to simulate the computations of reversible automata without explicitly writing down their complete descriptions which could be exponentially larger than the size of the explicit representations of the minimum equivalent automata.

Furthermore, the definition of reversibility has been relaxed, by considering finite automata whose computations can be reversed, at any point, by acceding to the last k symbols read from the input, for a fixed k . These devices are said to be “weakly irreversible”. Characterizations of languages accepted by weakly irreversible automata and languages not having any weakly irreversible automaton (“strongly irreversible” languages) have been given [C6].

During two short term scientific missions (supported by COST Action IC1405), he investigated, respectively:

- Deterministic pushdown transducers with respect to their ability to transform inputs into outputs in a reversible way (University of Gießen) [C9].
- Connections between reversible formal models (e.g., finite automata, counter machines) and reversible programming languages (University of Copenhagen) [P1].

SCIENTIFIC PRODUCTION

JOURNAL PAPERS

Published:

- [J1] Giovanna J. Lavado, Giovanni Pighizzini, and Luca Prigioniero:
Minimal and Reduced Reversible Automata
Journal of Automata, Languages and Combinatorics 22(1-3), pp. 145-168, 2017.
DOI: 10.25596/jalc-2017-145
- [J2] Giovanni Pighizzini and Luca Prigioniero:
Limited Automata and Unary Languages
Information and Computation 266, pp. 60-74, 2019.
DOI: 10.1016/j.ic.2019.01.002
- [J3] Giovanna J. Lavado and Luca Prigioniero:
Concise Representations of Reversible Automata
International Journal of Foundations of Computer Science 30, pp. 1157-1175, 2019.
DOI: 10.1142/S0129054119400331
- [J4] Bruno Guillon and Luca Prigioniero:
Linear-Time Limited Automata
Theoretical Computer Science 798, pp. 95-108, 2019.
DOI: 10.1016/j.tcs.2019.03.037
- [J5] Bruno Guillon, Giovanni Pighizzini, and Luca Prigioniero:
Non-Self-Embedding Grammars, Constant-Height Pushdown Automata, and Limited Automata
International Journal of Foundations of Computer Science 31(8), pp. 1133-1157, 2020.
DOI: 10.1142/S0129054120420071
- [J6] Giovanni Pighizzini and Luca Prigioniero:
Non-self-embedding Grammars and Descriptive Complexity
Fundamenta Informaticae 180(1-2), pp. 103-122, 2021
DOI: 10.3233/FI-2021-2036
- [J7] Oscar H. Ibarra, Jozef Jirásek Jr., Ian McQuillan, Luca Prigioniero:
Space Complexity of Stack Automata Models
International Journal of Foundations of Computer Science 32(6), pp. 801-823, 2021.
DOI: 10.1142/S0129054121420090
- [J8] Bruno Guillon, Martin Kutrib, Andreas Malcher, and Luca Prigioniero:
Reversible Pushdown Transducers
Information and Computation 281, 2021.
DOI: 10.1016/j.ic.2021.104813

Accepted for publication:

- [J9] Giovanni Pighizzini and Luca Prigioniero:
Pushdown Automata and Constant Height: Decidability and Bounds
Acta Informatica, To appear.

Submitted:

- [J10] Bruno Guillon, Giovanna J. Lavado, Giovanni Pighizzini, and Luca Prigioniero:
Weakly and Strongly Irreversible Regular Languages
- [J11] Bruno Guillon, Giovanni Pighizzini, Luca Prigioniero, and Daniel Průša:
Converting Nondeterministic Two-Way Automata into Small Deterministic Linear-Time Machines
- [J12] Bruno Guillon, Giovanni Pighizzini, Luca Prigioniero, and Daniel Průša:
Weight-Reducing Turing Machines

PART OF BOOKS OR COLLECTIONS

Published:

- [P1] Bogdan Aman, Gabriel Ciobanu, Robert Glück, Robin Kaarsgaard, Jarkko Kari, Martin Kutrib, Ivan Lanese, Claudio Antares Mezzina, Lukasz Mikulski, Rajagopal Nagarajan, Iain C. C. Phillips, G. Michele Pinna, Luca Prigioniero, Irek Ulidowski, Germán Vidal:
Foundations of Reversible Computation
Selected Results of the COST Action IC1405
Lecture Notes in Computer Science 12070, pp. 1-40, 2020.
DOI: 10.1007/978-3-030-47361-7_1

CONFERENCE PAPERS

Published:

- [C1] Giovanna J. Lavado, Giovanni Pighizzini, and Luca Prigioniero:
Minimal and Reduced Reversible Automata
In Proceedings of Descriptive Complexity of Formal Systems (DCFS) 2016
July 6-8, Bucharest
Lecture Notes in Computer Science 9777, pp. 168-179, 2016.
DOI: 10.1007/978-3-319-41114-9_13
- [C2] Giovanna J. Lavado, Giovanni Pighizzini, and Luca Prigioniero:
Minimal and Reduced Reversible Automata - Extended Abstract
In Proceedings of Italian Conference on Theoretical Computer Science (ICTCS) 2016
September 7-9, Lecce
CEUR Workshop Proceedings 1720, pp. 234-239, 2016.
- [C3] Giovanna J. Lavado and Luca Prigioniero:
Concise Representations of Reversible Automata
In Proceedings of Descriptive Complexity of Formal Systems (DCFS) 2017
July 3-5, Milan
Lecture Notes in Computer Science 10316, pp. 238-249, 2017.
DOI: 10.1007/978-3-319-60252-3_19
- [C4] Giovanni Pighizzini and Luca Prigioniero:
Limited Automata and Unary Languages
In Proceedings of Developments in Language Theory (DLT) 2017
August 7-11, Liège
Lecture Notes in Computer Science 10396, pp. 308-319, 2017.
DOI: 10.1007/978-3-319-62809-7_23
- [C5] Giovanni Pighizzini and Luca Prigioniero:
Non-Self-Embedding Grammars and Descriptive Complexity
In Proceedings of Non-Classical Models of Automata and Applications (NCMA) 2017, pp. 197-209.
August 17-18, Prague

- [C6] Giovanna J. Lavado, Giovanni Pighizzini, and Luca Prigioniero:
Weakly and Strongly Irreversible Regular Languages
 In Proceedings of Automata and Formal Languages (AFL) 2017
 September 4-6, Debrecen
 Electronic Proceedings in Theoretical Computer Science 252, pp. 143-156, 2017.
 DOI: 10.4204/EPTCS.252.15

- [C7] Bruno Guillon and Luca Prigioniero:
Linear-Time Limited Automata
 In Proceedings of Descriptive Complexity of Formal Systems (DCFS) 2018
 July 23-25, Halifax (NS)
 Lecture Notes in Computer Science 10952, pp. 126-138, 2018.
 DOI: 10.1007/978-3-319-94631-3_11

- [C8] Bruno Guillon, Giovanni Pighizzini, and Luca Prigioniero:
Non-Self-Embedding Grammars, Constant-Height Pushdown Automata, and Limited Automata
 In Proceedings of Conference on Implementation and Applications of Automata (CIAA) 2018
 July 30-August 2, Charlottetown (PEI)
 Lecture Notes in Computer Science 11088, pp. 366-378, 2018.
 DOI: 10.1007/978-3-319-94812-6_16

- [C9] Bruno Guillon, Martin Kutrib, Andreas Malcher, and Luca Prigioniero:
Reversible Pushdown Transducers
 In Proceedings of Developments in Language Theory (DLT) 2018
 September 10-14, Tokyo
 Lecture Notes in Computer Science 11088, pp. 354-365, 2018.
 DOI: 10.1007/978-3-319-98654-8_29

- [C10] Bruno Guillon, Giovanni Pighizzini, Luca Prigioniero, and Daniel Průša:
Two-way Automata and One-Tape Machines: Read Only versus Linear Time
 In Proceedings of Developments in Language Theory (DLT) 2018
 September 10-14, Tokyo
 Lecture Notes in Computer Science 11088, pp. 366-378, 2018.
 DOI: 10.1007/978-3-319-98654-8_30

- [C11] Bruno Guillon, Giovanni Pighizzini, and Luca Prigioniero:
On Some Succinct Representation of Regular Languages - Extended Abstract
 In Proceedings of Italian Conference on Theoretical Computer Science (ICTCS) 2018
 September 18-20, Urbino
 CEUR Workshop Proceedings 2243, pp. 203-207, 2018.

- [C12] Bruno Guillon and Luca Prigioniero:
Linear-Time Limited Automata - Extended Abstract
 In Proceedings of Italian Conference on Theoretical Computer Science (ICTCS) 2018
 September 18-20, Urbino
 CEUR Workshop Proceedings 2243, pp. 208-212, 2018.

- [C13] Giovanni Pighizzini and Luca Prigioniero:
Pushdown Automata and Constant Height: Decidability and Bounds
 In Proceedings of Descriptive Complexity of Formal Systems (DCFS) 2019
 July 17-19, Košice
 Lecture Notes in Computer Science 11612, pp. 260-271, 2019.
 DOI: 10.1007/978-3-030-23247-4_20

- [C14] Giovanni Pighizzini and Luca Prigioniero:
Pushdown Automata and Constant Height: Decidability and Bounds - Extended Abstract
 In Proceedings of Italian Conference on Theoretical Computer Science (ICTCS) 2019
 September 9-11, Como
 CEUR Workshop Proceedings 2504, pp. 72-77, 2019.

- [C15] Oscar H. Ibarra, Jozef Jirásek Jr., Ian McQuillan, and Luca Prigioniero:
Space Complexity of Stack Automata Models
In Proceedings of Developments in Language Theory (DLT) 2020
May 11-15, Tampa (FL)
Lecture Notes in Computer Science 12086, pp. 137-149, 2020.
DOI: 10.1007/978-3-030-48516-0_11
- [C16] Luca Prigioniero
Regular Languages: To Finite Automata and Beyond (Invited Talk)
In Proceedings of AUTOMATA 2021
July 12-14, Marseille
OASlcs 90, pp. 2:1-2:16, 2021.
DOI: 10.4230/OASlcs.AUTOMATA.2021.2
- [C17] Martin Kutrib and Luca Prigioniero
Boolean Kernels of Context-Free Languages
In Proceedings of Conference on Implementation and Applications of Automata (CIAA) 2021
July 19-22, Bremen (Virtual Event)
Lecture Notes in Computer Science 12803, pp. 152-164, 2021.
DOI: 10.1007/978-3-030-79121-6_13

Date

2/12/2021

Place

Milan