

Mateusz G. Twardawa

Institute of Computing Science, Poznan University of Technology · Cybersecurity and Data Protection Department, PSNC

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Research interests

Complexity and context construction in evolution · Computational immunology and systems biomedicine · Machine learning for cybersecurity · Algorithms for consistent sentencing

Positions

- Oct 2021 – present University assistant, Institute of Computing Science, Poznan University of Technology
- Dec 2017 – present Researcher, Cybersecurity and Data Protection Department, Poznan Supercomputing and Networking Center

Education

- in progress **PhD candidate**
Thesis: “Complexity flow graphs: formalism and methods for measuring complexity as a system–environment relation”
Poznan University of Technology
- 2019 **MSc in Bioinformatics (biological sciences)**
Thesis: “Modelowanie procesu konstrukcji niszy w ewolucji somatycznej nowotworu” (Modelling niche construction in the somatic evolution of cancer)
Inter-university programme of the Faculty of Computing, Poznan University of Technology and the Faculty of Biology, Adam Mickiewicz University in Poznań
Supervisor: prof. dr hab. inż. Piotr Formanowicz
- 2018 **MSc in Biology (natural sciences)**
Thesis: “Ubarwienie samców gupika *Poecilia reticulata* a stopień ich zapasozyczenia żyropalcami *Gyrodactylus turnbulli* (Monogenea)” (Male colouration in the guppy *Poecilia reticulata* and infection intensity with the monogenean *Gyrodactylus turnbulli*)
Faculty of Biology, Adam Mickiewicz University in Poznań
Supervisor: prof. dr hab. Jacek Radwan
- 2014 **BSc in Biology, specialisation: experimental biology (natural sciences)**
Thesis: “Wpływ wielkości ciała i doświadczenia w walkach na agresywność samców roztocza *Sancassania berlesei*” (Effects of body size and fighting experience on aggressiveness in males of the mite *Sancassania berlesei*)
Faculty of Biology, Adam Mickiewicz University in Poznań
Supervisor: prof. dr hab. Jacek Radwan

Research projects

- May 2026 – May 2029 **JURIDICA — Integrated platform supporting decisions and case analyses for merging penalties and penal measures in criminal cases**
Specialist in algorithms and statistics.
- Jan 2026 – Dec 2028 **PUCHACZ — Platform for obtaining characteristics of adversaries and cyber threats**
Specialist in applications of artificial intelligence in cybersecurity.
- Mar 2023 – Dec 2024 **Guideline-based sentencing algorithms — Algorithms based on sentencing guidelines as a counter-proposal to “AI courts”**
Data analysis and AI: algorithm design, data analysis, sentencing-recommendation models, publications.
- Mar 2022 – Dec 2024 **Młoda Kadra — Algorithmic complexity in a cellular-automaton model of a context-constructing system, analysed with algorithmic information dynamics**
Principal investigator and sole researcher: simulations and their implementation, analysis, publications.

Oct 2021 – Dec 2024	MALWINA — MALWare IN a box: AI-based platform for analysing malware and the traces it leaves on devices Lead machine-learning researcher; led a small team.
Dec 2017 – Aug 2019	SCADvance — SCADa Advance: methods improving the security of industrial networks in the power sector Lead machine-learning researcher (AI-based anomaly detection in industrial networks); led a small team. Results were deployed in practice.
Jul 2013 – Mar 2014	OPUS 2 — Effects of population size and density on survival and reproductive success of alternative male morphs in the mite <i>Rhizoglyphus echinopus</i> Maintaining mite cultures, heritability analysis, experiments.
Jun – Aug 2013	Reintroduction of the edible dormouse (<i>Glis glis</i>) in Western Poland Release and radio-tracking of selected individuals in the Barlinek-Gorzów Landscape Park.

Publications (14)

14. Szubert B., Twardawa M., Formanowicz P. (2026), Sieci Petriego a Metody Znajdowania Minimalnych Zbiorów Prekursorów w Projektowaniu Domen Sygnałowych Receptorów CAR-T (eng. Petri Nets and Methods for Finding Minimal Precursor Sets in CAR-T Receptor Signal Domain Design), Rozdział w monografii: Automatyzacja procesów dyskretnych. Teoria i zastosowania. Pod redakcją: Andrzeja Świerniaka i Jolanty Krystek, Wydawnictwo Politechniki Śląskiej, Gliwice, 2026, in press
13. Świątkowska B. (host), Domaradzka A., Misiak T. and Twardawa M. (2025) "Inteligentne miasto: między innowacją a bezpieczeństwem : debata z udziałem: socjolożki Anny Domaradzkiej, wiceprezesa Zarządu Fundacja Polska Bezgotówkowa, Tomasza Misiaka oraz badacza problematyki cyberbezpieczeństwa Mateusza Twardawy", In: "Od katastrof do odporności. Gotowość miasta na sytuacje kryzysowe" Pod redakcją: Macieja Frąckowiaka oraz Bogny Świątkowskiej, Wydział Rozwoju Miasta, Urząd Miasta Poznania, 978-83-950369-7-2, IX edycja Forum Rozwoju Miast, 13-14.10.2025, Poznań, Polska
12. Kiejnich-Kruk K., Twardawa M., Formanowicz P. (2025) Overcoming Sentencing Inconsistency – A Proposal for Algorithmic Guidelines and the Juridical Misalignment Index. Artificial Intelligence and Law; doi: 10.1007/s10506-025-09492-4
11. Twardawa M., Formanowicz P., Formanowicz D. (2025) The Interplay Between Carotid Intima-Media Thickness and Selected Serum Biomarkers in Various Stages of Chronic Kidney Disease. Biomedicines 2025; 13(2):335; doi: 10.3390/biomedicines13020335
10. Twardawa M., Gutowska K., Formanowicz P. (2024), Exploring relationship between hypercholesterolemia and instability of atherosclerotic plaque - an approach based on a matrix population model, Journal of Bioinformatics and Computational Biology 22(6) doi: 10.1142/S021972002450029X
9. Twardawa M., Formanowicz P. (2024), Grafy przepływu złożoności - definicja, przykłady i możliwe kierunki zastosowań (eng. Complexity flow graphs - definition, examples and possible applications), Rozdział w monografii: Automatyzacja procesów dyskretnych. Teoria i zastosowania. Pod redakcją : Andrzeja Świerniaka i Jolanty Krystek, Wydawnictwo Politechniki Śląskiej, Gliwice, 2024, pp. 261-284, ISBN 978-83-7880-972-2
8. Twardawa, M. G., Smolik, M., Rakowski, F., Kwiatkowski, J., and Meyer. N. (2024), 'Estimating vulnerability of industrial network infrastructure in Central and Eastern Europe', Security and Defence Quarterly, 47(3), doi: 10.35467/sdq/190350
7. Twardawa, M. G., Smolik, M., Rakowski, F., Kwiatkowski, J., and Meyer. N. (2024), 'SCADvanceXP - an intelligent Polish system for threat detection and monitoring of industrial networks', Security and Defence Quarterly, 48(4), doi: 10.35467/sdq/177655
6. Kiejnich-Kruk K., Twardawa M., Formanowicz P. (2023) Towards automated recommendations for drunk driving penalties in Poland - a case study analysis in selected court, Foundations of Computing and Decision Sciences, 48, 4, 425-451. doi: 10.2478/fcds-2023-0019

5. Twardawa M., Formanowicz P., Formanowicz D. (2022) Chronic Kidney Disease as a Cardiovascular Disorder - Tonometry Data Analyses. *International Journal of Environmental Research and Public Health*. 2022; 19(19):12339; doi: 10.3390/ijerph191912339
4. Twardawa M., Formanowicz P. (2022), Wieloagentowa symulacja polaryzacji makrofagów towarzyszących nowotworom (eng. Multiagent simulation of tumor-associated macrophages polarisation), Rozdział w monografii: Automatyzacja procesów dyskretnych. Teoria i zastosowania. Vol II. Pod redakcją : Andrzeja Świerniaka i Jolanty Krystek, Wydawnictwo Politechniki Śląskiej, Gliwice, 2022, pp. 113-121, ISBN 978-83-7880-854-1
3. Kasprzak Ł., Twardawa M., Formanowicz P., Formanowicz D., (2022) The Mutual Contribution of 3-NT, IL-18, Albumin, and Phosphate Foreshadows Death of Hemodialyzed Patients in a 2-Year Follow-Up. *Antioxidants* 2022, 11, 355. doi: 10.3390/antiox11020355
2. Dobski M., Frankowski G., Meyer N., Pilc M., Twardawa M. (2018) Zastosowanie metod uczenia maszynowego i zaawansowanego przetwarzania zdarzeń dla ochrony przemysłowych sieci infrastruktury krytycznej (eng. Applying Methods of Machine Learning and Complex Event Processing for Protection of Critical Infrastructure Industrial Networks), *Przegląd Policyjny* 4, 2018 (132); doi: 10.5604/01.3001.0013.6685
1. Radwan, J., Łukasiewicz, A. & Twardawa M. (2014) Colony size, but not density, affects survival and mating success of alternative male reproductive tactics in a polyphenic mite, *Rhizoglyphus echinopus* *Behav Ecol Sociobiol* 68: 1921; doi: 10.1007/s00265-014-1787-7

Talks and posters (27)

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| 2026 | Twardawa M., "Metody analizy i przeciwdziałania zaawansowanym cyberatakom z wykorzystaniem krajowej infrastruktury badawczej Puchacz", <i>CYBERSECURITY DAY 2026</i> , Częstochowa, Poland (presentation) |
| 2025 | Twardawa M., "Modeling the Evolution of the Adaptive Immune Response: How to Overcome the Unpredictability of Pathogen Diversity?", <i>9th Workshop on Bioinformatics meets Machine Learning</i> , Mittweida, Germany (presentation) |
| 2025 | Domaradzka A., Misiak T., Twardawa M., Świątkowska B. (host), "Inteligentne miasto: między innowacją a bezpieczeństwem", <i>Forum Rozwoju Miast w ramach Europejskiego Forum Samorządowego - Local Trends</i> , Poznan, Poland (Panel discussion) |
| 2025 | Twardawa M., "AI in Bioinformatics: Cybersecurity Risks, Model Attacks and the Rising Threat of Scientific Misuse", <i>Laboratory of Algorithm Design and Programming Systems CS PUT Seminars</i> , Poznan, Poland (presentation) |
| 2025 | Twardawa M., "Attacks on Artificial Intelligence Models and Cybersecurity in Bioinformatics", <i>BioMeeting 2025</i> , Masłów Pierwszy, Poland (guest talk) |
| 2024 | Twardawa M. , Formanowicz P., "Grafy przepływu złożoności - definicja, przykłady i możliwe kierunki zastosowań", <i>XXIII Krajowa Konferencja Automatyzacji Procesów Dyskretnych</i> , Zakopane, Poland (presentation) |
| 2024 | Twardawa M. , Formanowicz P, "Quantification of protein active sites evolvability with complexity flow graphs", <i>Symposium of the Polish Bioinformatics Society 2024</i> , Warsaw, Poland (poster) |
| 2024 | Twardawa M. , Smolik M., "AI based protection and monitoring of industrial networks with SCADvance XP system - Continuous Development of the system - Key Results of the IDS Utilities Project", <i>International Conference Societal and technological determinants of security: Adaptive strategies for information and cyber challenges.</i> , Warsaw, Poland (online) (presentation) |
| 2024 | Twardawa M. , Formanowicz P., "Complexity flow graphs and demonic landscapes", <i>Laboratory of Algorithm Design and Programming Systems CS PUT Seminars</i> , Poznan, Poland (presentation) |
| 2023 | Twardawa M. , Formanowicz P., "Complexity flow graphs", <i>Dynamics of biological systems: emergent phenomena at different scales</i> , Kraków, Poland (presentation) |

- 2023 Twardawa M., "Artificial intelligence in cybersecurity – examples of AI based systems developed at PSNC", *Laboratory of Algorithm Design and Programming Systems CS PUT Seminars*, Poznan, Poland (presentation)
- 2022 Twardawa M. , Formanowicz P., "Wieloagentowa symulacja polaryzacji makrofagów towarzyszących nowotworom", *XXII Krajowa Konferencja Automatyzacji Procesów Dyskretnych*, Zakopane, Poland (presentation)
- 2022 Twardawa M. , Formanowicz P., "Algorithmic aspects of niche construction derived problems", *ICOLE 2022 International Colloquium Lessach*, Lessach, Austria (presentation)
- 2021 Twardawa M. , Formanowicz P., "Multi-agent model of cancer hypoxia adaptation", *Autumn Conference PTBI*, Online (poster)
- 2021 Twardawa M. , Formanowicz P., "Simulation of eco-evolutionary aspects of cancer hypoxia adaptation", *Conference of Young Ecologists & Evolutionary Biologists*, Online (poster (The best poster award!))
- 2021 Twardawa M. , Formanowicz P., "Modelling Niche Construction Process in Somatic Evolution of Cancer", *Laboratory of Algorithm Design and Programming Systems CS PUT Seminars*, Poznan, Poland (presentation)
- 2019 Twardawa M., "Sabotaż w sieciach infrastruktury krytycznej i jego detekcja za pomocą metod sztucznej inteligencji", *V Ogólnopolska Konferencja Naukowa "Teoretyczny i empiryczne aspekty badań nad bezpieczeństwem międzynarodowym"*, Toruń, Poland (presentation)
- 2018 Twardawa M. , Formanowicz P., "Evolutionary perspective on a problem of complexity of living matter - does life have to evolve towards more complex forms?", *Laboratory of Algorithm Design and Programming Systems CS PUT Seminars*, Poznan, Poland (presentation)
- 2018 Twardawa M. , Dobski M., Frankowski G., Meyer N., Samborski K., "Industrial network behavior monitoring using ensemble forecasting machine learning techniques", *Applied Data Science Conference on IFIP World Computer Congress*, Poznan, Poland (presentation)
- 2018 Twardawa M., ""Once there were bacteria, now there is New York" - some theory behind evolution of complex life", *II Conference of Young Evolutionary Biologists*, Kraków, Poland (presentation)
- 2018 Frankowski G., Meyer N., Twardawa M., "Bezpieczeństwo protokołów sieci przemysłowych w świetle badań nad zagrożeniami infrastruktur krytycznych", *PSNC Seminars*, Poznan, Poland (presentation)
- 2016 Twardawa M., "Wykorzystanie teorii informacji w biologii ewolucyjnej", *VII Studencka Konferencja Biologii Ewolucyjnej*, Kraków, Poland (presentation)
- 2016 Twardawa M., "Pokonywanie nieprzewidywalności środowiska", *Jubileuszowa Konferencja Koła Naukowego Przyrodników UAM*, Poznan, Poland (presentation)
- 2014 Łukasiewicz A. , Twardawa M. , Radwan J., "Wpływ wielkości i zagęszczenia populacji na dostosowanie samców rozkruszka korzeniowego (*Rhizoglyphus echinopus*)", *III Konferencja Naukowo-Dydaktyczna Wydziału Biologii UAM*, Poznan, Poland (poster)
- 2014 Twardawa M. , Łukasiewicz A., Radwan J., "Polimorfizm samców *Rhizoglyphus echinopus*", *IV Kopernikańskie sympozium Nauk Przyrodniczych*, Toruń, Poland (poster)
- 2014 Twardawa M., "Rola i mechanizm eksploatacji sensorycznej w doborze płciowym", *VI Studencka Konferencja Biologii Ewolucyjnej*, Kraków, Poland (presentation)
- 2013 Twardawa M. , Łukasiewicz A., Radwan J., "Male polymorphism in *Rhizoglyphus echinopus*", *I Polish Evolutionary Conference*, Kraków, Poland (poster)

Teaching

- 2019/2020 – present Discrete Mathematics (classes) — Bioinformatics, Computer Science, Artificial Intelligence (in English) · BSc, Poznan University of Technology
- 2020/2021 – present Systems Biology (laboratory) — Bioinformatics · MSc, Poznan University of Technology

2020/2021 – present	Systems Approaches in Biomedical Research (lectures, classes, laboratory (since 2025/2026)) — Bioinformatics · MSc, Poznan University of Technology
2020/2021 – present	Bioinformatics (elective) (laboratory) — Computer Science · BSc — introductory classes on molecular biology (all laboratories in 2021/2022), Poznan University of Technology
2022/2023 – present	Phylogenetic Analysis (lectures, laboratory) — Bioinformatics · MSc, Poznan University of Technology
2022/2023 – present	Computational Immunology (lectures, laboratory) — Bioinformatics · BSc (earlier also MSc), Poznan University of Technology
2023/2024 – present	Evolutionary Processes (lectures, classes) — Bioinformatics · BSc, Poznan University of Technology
2020/2021 – 2021/2022	Cybersecurity of Industrial Networks (within Renewable Energy Sources) (lectures, laboratory) — Computer Science · BSc, Collegium Da Vinci
2018/2019 – 2019/2020	Programming Basics (laboratory) — Bioinformatics · BSc, Poznan University of Technology

Service and mentoring

Thesis supervision: Assisted in the supervision of 4 bachelor's theses and 3 engineering theses (formal supervisor: Prof. Piotr Formanowicz).

Co-supervisor of the Bioinformatics Student Research Club (KNBi), Poznan University of Technology

Student research activity

2015 – 2017	Co-founder and leader of the Biocybernetics Section, Bioinformatics Student Research Club, Poznan University of Technology
2013 – 2016	Co-founder and leader of the Evolutionary Biology Section, Naturalists' Student Research Club, Adam Mickiewicz University in Poznań
2011 – 2015	Member of the In Vitro Culture Section, Naturalists' Student Research Club, Adam Mickiewicz University in Poznań
Feb 2015 – Aug 2017	Modelling M1/M2 macrophage polarisation
May 2015 – Dec 2016	Automated measurement of visual traits of male guppies from photographs with convolutional neural networks
Mar – Nov 2014	Heritability of female fecundity in <i>Rhizoglyphus robini</i> lines selected for alternative male morphs
Nov 2011 – May 2015	In-vitro micropropagation of <i>Chelidonium majus</i> L. from different explant types

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