

Alireza Modirshanechi

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Research Interests

My research lies at the intersection of **cognitive neuroscience** (*computational modeling, targeted experiment design, and model-based analysis of behavioral and neural data*) and **machine learning** (*reinforcement learning and Bayesian inference*). I formalize and organize psychological concepts—such as *surprise, curiosity, and sense of control*—to answer two fundamental questions: ‘**How do biological systems make intelligent decisions?**’ and ‘**How can we design artificial systems that do the same?**’

Education

- 2018 – 2024 ■ **Ph.D. in Computer and Communication Sciences**
EPFL, Lausanne, Switzerland.
• *Thesis Committee:* W. Gerstner (Advisor), S.J. Gershman, J. Gold, and M.W. Mathis.
• [Featured on the EPFL news](#).
- 2014 – 2018 ■ **B.Sc. in Electrical Engineering (Communication)**
Sharif University of Technology, Tehran, Iran (GPA: 19.12/20).

Employment

- 2026 – ■ **Tenure-Track Professor**
University of Göttingen, Germany.
• Running the Laboratory of Natural and Artificial Intelligence (LNAI).
- 2024 – 2026 ■ **Postdoctoral Researcher**
Helmholtz Institute (Munich) and MPI for Biological Cybernetics (Tübingen), Germany.
• *Host:* Eric Schulz and Peter Dayan.
• Developed an integrative account of sensing and seeking control in natural ([Modirshanechi et al. 2026, PsyArXiv](#)) and artificial systems ([Modirshanechi et al. 2026, arXiv](#)). Also contributed to foundation models of human cognition ([Binz et al. 2025, Nature](#)).
- 2018 – 2024 ■ **Ph.D. Student**
EPFL, Lausanne, Switzerland.
• *Supervisor:* Wulfram Gerstner.
• Developed a taxonomy of surprise and novelty definitions ([Modirshanechi et al. 2022, Journal of Mathematical Psychology](#)) and characterized their computational roles in human exploratory ([Modirshanechi et al. 2025, PNAS](#)) and adaptive behavior ([Xu* and Modirshanechi* et al. 2021, PLOS Comp. Biology](#)). Also worked on analyzing physiological and neuroimaging data (e.g., [Esmaeili et al. 2021, Neuron](#)).

Grants and Fellowships

- 2026 – 2032 ■ **The DFG Emmy Noether Programme**, ~1.7M EUR.
Project: *The sense of control in natural and artificial intelligence*.
- 2018 ■ **EPFL EDIC Fellowship**, ~51K CHF.

Selected Honors and Awards

- 2024 ■ Laureate of the **Dimitris N. Chorafas Foundation Award**.
- 2024 ■ Laureate of the **EPFL EDIC Thesis Distinction Award**.
- 2019 ■ Laureate of the annual **Teaching Assistant Award**, EPFL.
- 2018 ■ **Ranked 2nd** in the department’s best B.Sc. thesis competition, Sharif Uni. Tech.
- 2018 ■ **Ranked 2nd** in GPA among all entrants of 2014 (~200 students), Sharif Uni. Tech.
- 2014 ■ **Silver Medalist**, 45th International Physics Olympiad (IPHO), Kazakhstan.
- 2013 ■ **Gold Medalist**, 26th National Physics Olympiad, Iran.

Publications

∗: Joint first authors; †: Joint last authors; Underlined: Trainees working under my mentorship

Google Scholar profile: <https://scholar.google.com/citations?user=ysDOYB8AAAAJ&hl=en>

- [1] **Unifying goal-conditioned RL and unsupervised skill learning via control-maximization**
A **Modirshanechi**, B Eysenbach, P Dayan[†], E Schulz[†]. (2026)
arXiv preprint.
- [2] **A compositional model of semantic fluency**
SS Nath, A **Modirshanechi**[†], P Dayan[†]. (2026)
PsyArXiv preprint.
- [3] **Meta-learning as a principle for human-like visual representations**
C Demircan, M Binz, A **Modirshanechi**, E Schulz. (2026)
arXiv preprint.
- [4] **An integrative framework for the human sense of control**
A **Modirshanechi**, P Dayan[†], E Schulz[†]. (2026)
PsyArXiv preprint.
- [5] **Post-training makes large language models less human-like**
M Binz, E Akata, A Almaatouq, ..., A **Modirshanechi**, ..., X Zhang, J Zhu, E Schulz. (2026)
arXiv preprint.
- [6] **Representational similarity modulates neural and behavioral signatures of novelty**
S Becker, A **Modirshanechi**, W Gerstner. (2026)
Neuron 114 (10): 1863-1876.e17.
→ Preview by C Miehl and J Gjorgjieva: ‘*Novelty beyond counting*’
- [7] **Remembering the “When”: Hebbian memory models for the time of past events**
J Brea, A **Modirshanechi**, G Iatropoulos, W Gerstner. (2026)
PLOS Computational Biology 22 (7): e1014575.
- [8] **Learning is a fundamental source of behavioral individuality**
R Manna, J Brea, GV Braga, A **Modirshanechi**, I Tomic, AM Jaksic. (2026)
eLife 15, RP111235.
- [9] **Novelty as a drive of human exploration in complex stochastic environments**
A **Modirshanechi**, W Lin, HA Xu, MH Herzog, W Gerstner. (2025)
Proceedings of the National Academy of Sciences (PNAS) 122 (39): e2502193122.
- [10] **A foundation model to predict and capture human cognition**
M Binz, E Akata, M Bethge, ..., A **Modirshanechi**, ..., DU Wulff, H Xiong, E Schulz. (2025)
Nature, 644: 1002–1009.
- [11] **Merits of curiosity: a simulation study**
L Gruaz^{*}, A **Modirshanechi**^{*}, S Becker, J Brea. (2025)
Open Mind 9: 1037–1065.
- [12] **Computational models of intrinsic motivation for curiosity and creativity**
S Becker, A **Modirshanechi**, W Gerstner. (2024)
Behavioral and Brain Sciences, 47: e94.
- [13] **Distributed and specific encoding of sensory, motor, and decision information in the mouse neocortex during goal-directed behavior**
A Oryshchuk, C Sourmpis, ..., A **Modirshanechi**, W Gerstner, CCH Petersen[†], S Crochet[†]. (2024)
Cell Report, 43: 113618.
- [14] **Curiosity-driven exploration: foundations in neuroscience and computational modeling**
A **Modirshanechi**, K Kondrakiewicz, W Gerstner, S Haesler. (2023)
Trends in Neurosciences 46 (12): 1054–1066.
- [15] **Surprise and novelty in the brain**
A **Modirshanechi**, S Becker, J Brea, W Gerstner. (2023)
Current Opinion in Neurobiology 82: 102758.
- [16] **A taxonomy of surprise definitions**
A **Modirshanechi**, J Brea, W Gerstner. (2022)
Journal of Mathematical Psychology 110: 102712.
- [17] **Brain signals of a Surprise-Actor-Critic model: evidence for multiple learning modules in human decision making**
V Liakoni^{*}, MP Lehmann^{*}, A **Modirshanechi**, J Brea, A Lutti, W Gerstner[†], K Preuschoff[†]. (2022)
NeuroImage, 246: 118780.

- [18] **Novelty is not Surprise: human exploratory and adaptive behavior in sequential decision-making**
HA Xu*, A **Modirshanechi***, MP Lehmann, W Gerstner[†], MH Herzog[†]. (2021)
PLOS Computational Biology 17 (6): e1009070.
- [19] **Learning in volatile environments with the Bayes Factor surprise**
V Liakoni*, A **Modirshanechi***, W Gerstner, J Brea. (2021)
Neural Computation 33 (2): 269–340.
- [20] **Fitting summary statistics of neural data with a differentiable spiking network simulator**
G Bellec*, S Wang*, A **Modirshanechi**, J Brea[†], W Gerstner[†]. (2021)
Proc. of the 34th Conf. on Advances in Neural Information Processing Systems (NeurIPS): 18552–18563.
- [21] **Rapid suppression and sustained activation of distinct cortical regions for a delayed sensory-triggered motor response**
V Esmaeili*, K Tamuras*, SP Muscinelli, A **Modirshanechi**, ..., W Gerstner, CCH Petersen. (2021)
Neuron, 109 (13): 2183–2201.e9.
- [22] **Trial-by-trial surprise-decoding model for visual and auditory binary oddball task**
A **Modirshanechi**, MM Kiani, H Aghajan. (2019)
NeuroImage, 196: 302–317.
- [23] **Election vote share prediction using a sentiment-based fusion of Twitter data with Google Trends and online polls**
P Kassraie*, A **Modirshanechi***, H Aghajan. (2017)
Proc. of the 6th International Conf. on Data Science, Tech. and Applications (DATA 2017): 363–370.

Conference Talks and Posters

Contributed Talks:

- [1] **Seeking a sense of control: A normative perspective**
A **Modirshanechi**, P Dayan[†], E Schulz[†]
'Principles of Intrinsic Motivations in Biological and Artificial Agents' workshop at RLDM 2025 (Dublin)
- [2] **Representational similarity modulates neural and behavioral signatures of novelty**
S Becker, A **Modirshanechi**, W Gerstner
Cosyne 2024 (Lisbon)
- [3] **Novelty drives exploration, whereas surprise modulates learning**
A **Modirshanechi**, HA Xu, MP Lehmann, MH Herzog, W Gerstner
Bernstein 2021 (Online)

Selected Posters:

- [1] **An integrative framework for the sense of control**
A **Modirshanechi**, P Dayan[†], E Schulz[†]
CCN 2025 (Amsterdam), Cosyne 2026 (Lisbon), SBDM 2026 (Paris), and NeuroMonster 2026 (Rome)
- [2] **A principled framework for individual differences in neural networks**
M Mathony, A **Modirshanechi**[†], E Schulz[†]
NeuroMonster 2026 (Rome) and CogSci 2026 (Rio)
- [3] **A compositional model of semantic fluency**
SS Nath, A **Modirshanechi**[†], P Dayan[†]
CCN 2026 (New York)
- [4] **Seeking a sense of control: a normative perspective**
A **Modirshanechi**, P Dayan[†], E Schulz[†]
RLDM 2025 (Dublin)
- [5] **Merits of curiosity: a simulation study**
L Gruaz*, A **Modirshanechi***, S Becker, and J Brea
RLDM 2025 (Dublin)
- [6] **Novelty drives human exploration even when it is suboptimal**
A **Modirshanechi**, HA Xu, W Lin, MH Herzog, W Gerstner
Cosyne 2023 (Montreal), CCN 2023 (Oxford), & Bernstein 2023 (Berlin)
- [7] **Environmental similarity structure modulates neural and behavioral signatures of novelty**
S Becker, A **Modirshanechi**, W Gerstner
Bernstein 2023 (Berlin)
- [8] **Theories of surprise: definitions and predictions**
A **Modirshanechi**, J Brea, W Gerstner
Cosyne 2022 (Lisbon)

- [9] A bio-plausible implementation of novelty-guided exploration
S Becker, A Modirshanechi, W Gerstner
RLDM 2022 (Providence) & Bernstein 2022 (Berlin)
- [10] Model-based surprise modulates model-free learning
A Modirshanechi*, HA Xu*, MP Lehmann, MH Herzog[†], W Gerstner[†]
Cosyne 2021 (Online)

Selected Invited Talks

- 2026 ■ Munich Interactive Intelligence Initiative (MI3), LMU, Munich, Germany.
- 2026 ■ The symposium on Modeling the Predictive Brain, PuG conference, Heidelberg, Germany.
- 2026 ■ The Simons Collaboration on Ecological Neuroscience (SCENE; Online).
- 2026 ■ Joint meeting of Chris Donkin and Thorsten Pachur Labs, LMU-TUM, Munich, Germany.
- 2026 ■ Faculty of Mathematics and Computer Science, University of Göttingen, Germany.
- 2025 ■ Curiosity, Information Seeking, & Exploration Conference, Brown University, USA (Online).
- 2025 ■ Chris Summerfield Lab, Oxford, UK (Online).
- 2024 ■ Cognitive Neuro. Colloquium, Uni. Medical Center Hamburg-Eppendorf, Germany.
- 2024 ■ Charley Wu Lab, University of Tübingen, Germany (Online).
- 2024 ■ Sony CSL Paris, France (Online).
- 2024 ■ Matthias Gruber Lab, Cardiff University, UK (Online).
- 2024 ■ Theory kick-off of RTG Curiosity program in the University of Göttingen, Germany.
- 2024 ■ Institut de Neurosciences de la Timone (INT), Marseille, France.
- 2023 ■ Computational Phenomenology Discussion Group (Online).
- 2023 ■ Angelika Steger Lab, ETH Zurich, Switzerland.
- 2023 ■ Active Inference Institute (Online).
- 2022 ■ Eric Schulz Lab, MPI for Biological Cybernetics, Tübingen, Germany.
- 2022 ■ Sebastian Haesler Lab, Katholieke Universiteit Leuven, Belgium (Online).
- 2022 ■ Ilya Monosov Lab, University of Washington in St. Louis, US (Online).
- 2022 ■ Marcelo Mattar Lab, UC San Diego, US (Online).
- 2022 ■ Montreal AI-Neuro Seminar Series, Montreal, Canada (Online).
- 2021 ■ The Allen Institute, Seattle, US (Online).
- 2021 ■ EPFL Neuro Symposium, Lausanne, Switzerland (Online).

Teaching Experience

- 2019 – 2023 ■ **Teaching Assistant** in 8 Bachelor and Master courses
EPFL, Lausanne, Switzerland.
- Artificial Neural Networks and Reinforcement Learning (×4).
→ Taught a series of lectures on “Curiosity-Driven Exploration.”
 - Markov Chains and Algorithmic Applications (×3).
→ Received the Department Teaching Assistant Award.
 - Probability and Statistics.
- 2015 – 2018 ■ **Teaching Assistant** in 6 Bachelor courses
Sharif University of Technology, Tehran, Iran.
- Computational Neuroscience.
 - Communication Systems.
 - Engineering Mathematics (×2).
 - Signals and Systems.
 - Electromagnetism.
- 2013 – 2017 ■ **Advanced Physics Teacher**
National Organization for the Development of Exceptional Talents, Iran.
- Taught several classes for high school students preparing for the National and International Physics Olympiad.

Mentorship and Supervision

Ph.D. Students

- 2025 – ■ Nan Chen (co-supervised with Peter Dayan)
- 2024 – ■ Surabhi S Nath (co-supervised with Peter Dayan)
- 2024 – ■ Marvin Mathony (co-supervised with Eric Schulz)
- 2023 – 2024 ■ Lucas Gruaz (co-supervised with Wulfram Gerstner and Johanni Brea)
- 2021 – 2024 ■ Sophia Becker (co-supervised/mentored with Wulfram Gerstner)

M.Sc. Students

- 2022 ■ Yehya El Hassan (co-supervised with Johanni Brea)
- 2022 ■ Auguste Poiroux (co-supervised with Johanni Brea)
- 2020 ■ Anthony Jakob
- 2020 ■ Lucas Gruaz
- 2019 ■ Alexandru Mocanu (co-supervised with Martin Barry)
- 2018 ■ Manu Srinath Halvagal (co-supervised with Martin Barry)

B.Sc. Students

- 2017 – 2018 ■ Mahdiyar Shahbazi
- 2017 – 2018 ■ Alireza Shirzad
- 2017 – 2018 ■ Amir Hoseini
- 2017 – 2018 ■ Ali Shirali
- 2016 – 2018 ■ Erfan Khalaj

Service and Volunteer Work

- 2020 – ■ Author of **educational articles** in **Medium** Publications; selected articles:
 - ‘Why does the optimal policy exist?’ (more than 15K views)
 - ‘Is correlation distance a metric?’ (more than 10K views)
 - ‘What can we learn from posterior distributions?’ (more than 2K views)
- 2024 – ■ **Adhoc reviewer**:
 - Journals (alphabetically ordered):
 - Biological Psychiatry: CNNI
 - Cognition
 - Computational Brain & Behavior
 - Experimental Brain Research
 - Frontiers in Psychology
 - Journal of Mathematical Psychology
 - Learning and Motivation
 - Minds and Machines
 - Nature Communications
 - PLOS Computational Biology
 - PNAS
 - PNAS Nexus
 - Scientific Reports
 - Trends Open
 - Conferences and workshops (alphabetically ordered):
 - Cognitive Computational Neuroscience (CCN) Conference 2023 & 2025
 - Computational and Systems Neuroscience (Cosyne) 2026
 - NeurIPS Workshop: Data on the Brain & Mind 2025
 - NeurIPS 2026
- 2025 ■ **Workshop co-organizer** at **CCN 2025** (Amsterdam, The Netherlands)
Title: ‘What benchmarks are useful for cognitive science?’
- 2024 ■ **Workshop co-organizer** at **Cosyne 2024** (Lisbon, Portugal)
Title: ‘The predictive brain: from algorithms to mechanisms’
- 2022 ■ **Workshop co-organizer** at **Bernstein 2022** (Berlin, Germany)
Title: ‘Surprise in the brain: Theory and Experiments’
- 2022 – 2024 ■ **Volunteer** in **Review of Application Materials (RAMP)** program at EPFL to help prospective Ph.D. students with their applications (e.g., reviewing CVs, cover letters, etc.).
- 2020 – 2024 ■ **Volunteer** in the **EPFL Buddy program** (every year) to help 1st-year Ph.D. students at EPFL with starting their Ph.D (e.g., EPFL courses, life in Lausanne, etc.).