

# Matthew Ricci

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## Current position

*Zuckerman Postdoctoral Fellow*  
School of Computer Science and Engineering  
The Hebrew University of Jerusalem  
Supervisor: Mor Nitzan

## Areas of interest

Representation learning for dynamical systems  
Cell-cell and gene regulatory networks  
Neural dynamics in vision

## Education

- |      |  |
|------|--|
| 2020 | <i>Ph.D. in Computational Neuroscience</i><br>Brown University<br>Specialization: Neural dynamics, computer vision<br>Advisor: Thomas Serre<br>Dissertation: "Towards Systematic Vision: Limitations of Convolutional Neural Networks and Future Directions in Oscillatory Coding" |
| 2012 | <i>MA/BA in Mathematics</i><br>University of Pennsylvania<br>Specialization: Signal processing<br>Advisor: Philip Gressman   |
| 2012 | <i>BA in Musicology</i><br>University of Pennsylvania  |

Specialization: American modernism, modernist performance practice  
Advisors: Arman Schwartz, Emily Dolan

## Appointments held

|                          |  |
|--------------------------|--|
| Jul. 2020 -<br>Jul. 2021 | <i>Postdoctoral Associate</i><br>Data Science Initiative<br>Brown University<br>Supervisor: Stuart Geman                                       |
| Aug. 2018 -<br>Feb. 2018 | <i>Visiting Doctoral Researcher</i><br>Département d'informatique<br>École normale supérieure (Ulm)<br>Principal Investigator: Stéphane Mallat |
| 2013-2014                | <i>Research Assistant</i><br>Rutgers University Center for Cognitive Science<br>Principal Investigator: Randy Gallistel                        |

## Grants, honors & awards

|                               |   |
|-------------------------------|---|
| Jul. 1, 2021-                 | Zuckerman Postdoctoral Fellowship<br>Hebrew University of Jerusalem<br>Principal Investigator: Mor Nitzan |
| Sep. 1, 2017-<br>July 1, 2019 | NSF Graduate Research Fellowship<br>Award no. 1644760<br>Principal Investigator: Thomas Serre             |
| 2018                          | Brown University Graduate School Travel Grant   |
| 2017                          | CCN Travel Grant  |
| Jan. 1, 2015-<br>Jan. 1, 2017 | NIH Vision Training Grant<br>Award no. 5T32EY018080-08<br>Principal Investigator: Michael Paradiso        |
| 2012                          | Admitted to Phi Beta Kappa  |
| 2011                          | Submatriculated into graduate program, Department of Mathematics, University of Pennsylvania              |

## Peer-Reviewed Publications

### SUBMITTED

Moriel, N. Ricci, M., Nitzan, M. Let's Do the Time-Warp-Attend: Learning Topologically-Invariant Representations of Dynamical systems. (Submitted)

Ricci, M.G., Thackray, J., Tischfield, M., Abaira, V. Animal2Vec: Sequence embedding methods for computational ethology. (Submitted)

### PUBLISHED

Bohic, M., Pattison, L. A., Jhumka, Z. A., Rossi, H., Thackray, J. K., Ricci, M., Mossazghi, N., Foster, W., Ogundare, S., Twomey, C. R., Hilton, H., Arnold, J., Tischfield, M. A., Yttri, E. A., St. John Smith, E., Abdus-Saboor, I., and Abaira, V. E. (2023). Mapping the neuroethological signatures of pain, analgesia, and recovery in mice. *Neuron*. <https://doi.org/10.1016/j.neuron.2023.06.008>

Ricci, M., Kim, J., and Johansson, F. (2023). A computational passage-of-time model of the cerebellar Purkinje cell in eyeblink conditioning. *Frontiers in Computational Neuroscience*, 17. <https://doi.org/10.3389/fncom.2023.1108346>

Ricci, M., Moriel, N., Piran, Z., Nitzan, M, (2023) Phase2vec: Dynamical systems embedding with a physics-informed convolutional network. 10th International Conference on Learning Representations, ICLR 2023 - Conference Track Proceedings (Spotlight)

Gallistel CR, Johansson F, Jirenhed DA, Rasmussen A, Ricci M, Hesslow G (2022). Quantitative properties of the creation and activation of a cell-intrinsic duration-encoding engram. *Frontiers in Computational Neuroscience* Nov 3;16:1019812. doi: 10.3389/fncom.2022.1019812. PMID: 36405788; PMCID: PMC9669310.

Chalvidal, M., Ricci, M.G., Serre, T., VanRullen, R. (2021) Go With the Flow: Adaptive Control for Neural ODEs. 8th International Conference on Learning Representations, ICLR 2021 - Conference Track Proceedings

Alamia, A., Luo, C., Ricci, M.G., Kim, J., Serre, T. and VanRullen, R. (2020) Differential involvement of EEG oscillatory components in identity vs. spatial-relation reasoning tasks. *eNeuro*, 8 (1) ENEURO.0267-20.2020

Ricci, M., Cadène, R., & Serre, T. (2020). Same-different conceptualization : A machine vision perspective. *Current Opinion in Behavioral Sciences*, 37, 47–55. <https://doi.org/10.1016/j.cobeha.2020.08.008>

Ricci, M., and Serre, T. (2020). Hierarchical Models of the Visual System.

Encyclopedia of Computational Neuroscience, 1–14. [https://doi.org/10.1007/978-1-4614-7320-6\\_345-2](https://doi.org/10.1007/978-1-4614-7320-6_345-2)

Kim, J., Ricci, M.G., and Serre, T. (2018) Not-so-CLEVR: Learning same-different relations strains feedforward neural networks, *Journal of the Royal Society Interface*, 8(4), <https://doi.org/10.1038/35073582>

Ricci, M.G., Kim, J. and Serre, T. (2018) Same-Different Problems Strain Convolutional Neural Networks, *Proceedings of the 40th Annual Conference of the Cognitive Science Society*.

Ricci, M.G., and Gallistel, R. (2017). Accurate Step-Hold Tracking of Smoothly Varying Periodic and Aperiodic Probability. *Atten. Percept. Psychophys.*, 1–32. <https://doi.org/10.3758/s13414-017-1310-0>

## Technical Reports and Preprints

Ricci, M., Moriel, N., Piran, Z., Nitzan, M., Phase2vec: Dynamical systems embedding with a physics-informed convolutional network. `arXiv:2212.03857v1 [cs.LG]`

Ricci, M.G., Jung, M., Zhang, Y., Chalvidal, M., Soni, A., Serre, T. KuraNet: Systems of Coupled Oscillators that Learn to Synchronize. `arXiv:2105.02838 [nlin.AO]`

Bohic, M., Pattison, L.A., Jhumka, Z.A., Rossi, H., Thackray, J.K., Ricci, M.G., Foster, W., Arnold, J., Mossazghi, N., Yttri, E.A., Tischfield, M.A., Smith, E. S-J, Abdus-Saboor, I., Abaira, V. Behavioral and nociceptor states of inflammatory pain across timescales in 2D and 3D. `bioRxiv 2019.12.16.877829`

Ricci, M.G., Jung, M., Zhang, Y., Chalvidal, M., Soni, A., Serre, T. KuraNet: Systems of Coupled Oscillators that Learn to Synchronize. `arXiv:2105.02838 [nlin.AO]`

Chalvidal, M., Ricci, M.G., Serre, T., VanRullen, R. Go With the Flow: Adaptive Control for Neural ODEs. `arXiv:2006.09545 [cs.LG]`

Alamia, A., Luo, C., Ricci, M.G., Kim, J., Serre, T., VanRullen, R. Differential involvement of EEG oscillatory components in sameness vs. spatial-relation visual reasoning tasks `bioRxiv 2019.12.16.877829`

Gallistel, C. R., Johansson, F., Jirenhed, D.-A., Rasmussen, A., Ricci, M., and Hesslow, G. (2020). Quantitative Properties of the Creation and Activation of a Cell-Intrinsic Engram. *BioRxiv*, 2020.03.17.995258.

Ricci, M.G., Kim, J and Johansson, F. A Passage-of-time Model of the Cerebellar Purkinje Cell, 2016, [arXiv:1605.03060v2](https://arxiv.org/abs/1605.03060v2) [q-bio.NC]

## Works in Progress

Ricci, M., Moriel, M. Piran, Z., Nitzan, M. Spatial-Phase2vec: representation learning for reaction-diffusion models.

Theis, T., Thackray, J. Ricci, M.G., Tshang, M., Oputal, O. Mahmood, M., Vivinetto, A., Bernstein, A., Ruven, C., Tucker, A., Birch, D., Eisdorfer, J.T., Shrier, T., Kumar, S., Tysseling, V., Dulin, J., Sahni, V., Hollis, E.R., Schachner, M., Abaira, V. A machine-vision approach for automated locomotor recovery evaluation at millisecond timescales.

## Conferences, Talks and Workshops

### AS CONFERENCE PRESENTER

- |            |   |
|------------|---|
| May 2023   | Ricci, M., Moriel, N., Piran, Z., Nitzan, M “Phase2vec: Dynamical systems embedding with a physics-informed convolutional network”. 10th International Conference on Learning Representations, ICLR 2023 (Spotlight), Kigali, Rwanda. May 1-5 2023  |
| March 2023 | Ricci, M., Moriel, N., Piran, Z., Nitzan, M “Phase2vec: Dynamical systems embedding with a physics-informed convolutional network”. Physics of Life 2023. IOP. Harrowgate, UK. March 27-30, 2023  |
| Sep. 2022  | Ricci, M. “Learning Generalizable Representations of Dynamical Systems”. NETDATA22: Inverse Network Dynamics - Network structure and function from nonlinear dynamics and time series data. Dresden, Germany. Sep. 12-21 , 2022                     |
| Nov. 2021  | Mahmood, M., Theis, T., Ricci, M.G., Abaira, V. “A Machine-Vision Approach for Automated Locomotor Recovery Evaluation at Millisecond Timescales”. Annual Biomedical Research Conference for Minority Students (ABRCMS), Virtual. Nov. 10-13, 2021. |
| July 2021  | Theis, T., Thackray, J.K., Ricci, M.G., Abaira, V. “A machine vision approach for automated locomotor recovery at millisecond timescales”. 38th Annual National Neurotrauma Symposium, Virtual. July 11-14, 2021.                                   |
| June 2020  | Ricci, M.G, “N’Sync: Learning to Synchronize in Complex Networks” Brown University Unconference, Virtual. June 29-30, 2020.   |
| Feb. 2020  |   |

Ricci, M.G., Zhang, Y., Soni, A., Jung, M., Serre, T. “Kura-Net: Exploring systems of coupled oscillators using deep learning” Poster, COSYNE 2020. Denver, USA. February 27-March 2, 2020.

Feb. 2019 Ricci, M.G., Windolf, C., Serre, T. “A Formal Model of Neural Synchrony for Unsupervised Image Grouping”. Poster, COSYNE 2019. Lisbon, Portugal. February 28-March 3, 2019.

July 2018 “Not-So-CLEVR: Same-different problems strain feedforward neural networks”. 40th Annual Meeting of the Cognitive Science Society”, July 25, 2018. Monona Terrace Community and Convention Center, Madison, WI.

Sep. 2017 “A Dichotomy of Visual Relations, Or the Limits of Convolutional Neural Networks”, Conference on Cognitive Computational Neuroscience (CCN), September 6-8, 2017. Columbia University, NYC.

Aug. 2017 “Deep RL Bootcamp”, August 26-27, 2017, University of California, Berkeley. (Accepted)

June 2015 “Cell autonomous metabotropic signaling”, Kavli Futures Symposium – The Synapse Hypothesis: To be or not to be. June 25-26, 2015. University of California, Santa Barbara

#### AS GUEST SPEAKER

March 2022 “Go with the flow: Representation Learning for Dynamical Systems”. Hebrew University of Jerusalem. School of Computer Science and Engineering. March 10, 2022

June 2020 “The Kuramoto Model Meets Machine Learning: Some Early Results in the Statistical Modeling of Oscillatory Systems”. University of Ghent. PI: Tom Verguts. June 19, 2020

Nov. 2019 “The Serre Lab: From machine learning to biology and back again”, Information Theory (APMA 1710). Instructor: Govind Menon. November 11, 2019.

Oct. 2019 “Coupled Oscillators for Data Science: A Research Program”, Serre Lab-ANITI Joint Meeting, PIs: Thomas Serre, Rufin VanRullen. October 24, 2019.

Sep. 2019 “Review: Coupled Oscillators for Perceptual Grouping”, Carney Institute for Brain Science. September 5, 2019.

April 2019 “Systems of coupled neural oscillators: Results and applications based on Slotine, Izhikevich, Kuramoto”, Carney Institute for Brain Science. April

30, 2019.

- Aug. 2019 “Kosterlitz Machines”, Carney Institute for Brain Science. August 7, 2019.
- Oct. 2018 “Get Rhythm: Object Multiplexing in Phase Neural Networks”. Centre de Recherche Cerveau et Cognition, Toulouse, France. October 2., 2018
- March 2018 “Reinforcement Learning 101”, Computational Cognitive Science (CLPS 1291). Instructor: Thomas Serre. March 22, 2018.
- Dec. 2017 “Visual Relations and Convolutional Networks”, Perception & Action Seminar, Brown University, Department of Cognitive, Linguistic and Psychological Sciences. December 7, 2017
- Oct. 2015 “Contemporary Problems in Vision”, Brown University, Department of Cognitive, Linguistic and Psychological Sciences. October 9, 2015.
- June 2015 “Contemporary Problems in Vision”, UCL Gatsby Computational Neuroscience Unit. June 26, 2015.
- June 2015 “Challenges to Hebbianism: A Case from Cerebellar Learning”, UCL Gatsby Computational Neuroscience Unit, June 25, 2015.
- June 2015 “Challenges to Hebbianism: A Case from Cerebellar Learning”, University of Geneva. June 3, 2015.
- June 2015 “Challenges to Hebbianism: A Case from Cerebellar Learning”, Neurospin. June 5, 2015.
- March 2014 “Non-stationary Bernoulli Processes: Ideal Observers’ Predictions and Surprisals”, Rutgers University Center for Cognitive Science. March 28, 2014.

#### AS ORGANIZER

- April 2018 “Beyond Deep Learning Workshop: Session 2”, Brown University, April 6, 2018  
Speakers: David Heeger (NYU), Dima Amso (Brown University), Tom Griffiths (UC Berkeley)
- Jan. 2018 “Beyond Deep Learning Workshop: Session 1”, Brown University, January 18-19, 2018  
Speakers: Matthias Bethge (Universität Tübingen), Randy Gallistel (Rutgers University), Gary Marcus (NYU), Samuel Gershman (Harvard)

## Teaching

BROWN UNIVERSITY

2019-2021

*Mentor*

Visiting undergraduate researcher, Yuwei Zhang

Nankai University

Project: An end-to-end differentiable clustering algorithm using the Kuramoto Model

2019

*Teaching Assistant*

Human Cognition (CLPS 0200)

Instructor: Katheryn Spoehr

2018

*Teaching Assistant*

Deep Learning in Brains, Minds and Machines (CLPS 1950)

Instructor: Thomas Serre

2017

*Teaching Assistant*

Introduction to Programming for Mind, Brain and Behavior (CLPS 1292)

Instructor: Thomas Serre



2016-2018

*Mentor*

Masters student, Charles Windolf

Department of Applied Mathematics, Brown University

Project: Angular Gibbs random fields for image processing

UNIVERSITY OF PENNSYLVANIA

2012-2013

*Tutor*

Multivariable calculus, linear algebra (MATH 103, MATH 104)

Department of Mathematics

PRINCETON REVIEW

2013

*SAT Instructor*

2013

*MCAT Instructor*

## References

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### **Charles Randy Gallistel**

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