Michael T. Gastner

Contact Information

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Personal Profile

Assistant Professor at Yale-NUS College in Singapore. Internationally experienced educator at the under- and postgraduate level. Author of highly cited articles on data visualization and complex systems. Mastermind behind the go-cart.io project that makes cartogram generation easy and user-friendly.

Academic Positions

Current since Jul 2015	Yale-NUS College (Singapore): Assistant Professor *Mathematical, Computational and Statistical Sciences* Yale-NUS is the first liberal arts college in Singapore. I teach and design modules for the "Common Curriculum" and specialized elective courses. I also supervise undergraduate research culminating in "Capstone Projects" in the students' senior year.
Jun 2015 – Nov 2013	Hungarian Academy of Sciences (Budapest): Marie Curie Fellow *Institute of Technical Physics and Materials Science* Independent research in statistical physics, network analysis and game theory
Oct 2013 – Sep 2012	University of Bristol (UK): Lecturer *Department of Engineering Mathematics* Independent research in complex systems, PhD project supervision, lecturer for under- and postgraduate courses
Aug 2012 – Dec 2009	Imperial College (London): Junior Research Fellow *Mathematics Department* Independent research in complexity and network science, lecturer of postgraduate courses
Nov 2009 – May 2008	Carl von Ossietzky Universität, Oldenburg (Germany): Research Fellow *Institute for Chemistry and Biology of the Marine Environment* Mathematical modelling of bioinvasion mediated by the network of cargo ships, supported by a Computational Science Fellowship of the Volkswagen Foundation
May 2008 – Oct 2005	Santa Fe Institute (USA): Postdoctoral Fellow Research in complex systems and interdisciplinary science

Qualifications

Aug 2005 – Sep 2000 | University of Michigan (USA): PhD
Physics Department | Advisor: Prof. M. E. J. Newman
Thesis: "Spatial distributions – density-equalizing maps, facility location, and two-dimensional networks"

Jul 2000 – Oct 1997 | Albert-Ludwigs-Universität Freiburg (Germany): Vordiplom
Physics Department
Average mark: 1.0 (best possible mark on a scale from 1.0 to 6.0)

Selected Publications

See page 9 for complete publication list

Cartogram, Fast algorithm

M. T. Gastner, V. Seguy and P. More
Fast flow-based algorithm for creating density-equalizing map projections
Proc. Natl. Acad. Sci. U.S.A. 115(10):E2156–E2164 (2018)
Geographic maps are a popular means to visualize spatial statistics. Conventionally, each map region is displayed with an area proportional to the actual land area. However, equal-area maps can grossly misrepresent demographic data: densely populated cities should be given more prominence than large, but sparsely populated territories. Cartograms solve this problem by rescaling map regions in proportion to, for example, population or gross domestic products. Here we describe and benchmark a fast flow-based algorithm that computes cartograms in a matter of seconds.

Opinion formation

M. T. Gastner, B. Oborny and M. Gulyás
Consensus time in a voter model with concealed and publicly expressed opinions
J. Stat. Mech. Theory Exp. 2018(6):063401 (2018)
The voter model is a simple agent-based model to mimic opinion dynamics in social networks. Although the basic voter model is theoretically intriguing, it misses an important feature of real opinion dynamics: it does not distinguish between an agent's publicly expressed opinion and her inner conviction. Here we introduce the *Concealed Voter Model* where we add a second, concealed layer of opinions to the public layer. By analyzing the evolution of the opinions, we derive by how much concealment slows down a consensus.

Network analysis

P. Kaluza, A. Kölzsch, **M. T. Gastner** and B. Blasius
The complex network of global cargo ship movements
J. Royal Soc. Interface 7(48):1093–1103 (2010)
The global network of merchant ships plays a crucial role in human mobility, the exchange of goods and the spread of invasive species. We use information about the itineraries of 16 363 cargo ships during the year 2007 to construct a network of links between ports. We show that bulk dry carriers, container ships and oil tankers differ in their mobility patterns and networks. Container ships follow regularly repeating paths whereas bulk dry carriers and oil tankers move less predictably between ports. The network of all ship movements possesses a heavy-tailed distribution with systematic differences between ship types.

Cartogram, diffusion algorithm

M. T. Gastner and M. E. J. Newman
Diffusion-based method for producing density-equalizing maps
Proc. Natl. Acad. Sci. U.S.A. 101(20):7499–7504 (2004)
Cartograms are maps in which the sizes of geographic regions (e.g. countries, provinces) appear in proportion to their population. Such maps are invaluable for data visualization. Unfortunately, to scale regions and still have them fit together, one is normally forced to distort the regions' shapes, potentially resulting in maps that are difficult to read. Here we present a technique based on ideas borrowed from elementary physics that suffers from none of these drawbacks.

Teaching experience

Data Analysis and Visualization with R
Yale-NUS College (2018, 2016)

This course teaches how to use the programming language R for analyzing and presenting statistical data. Starting from the fundamentals of R (data types, flow control), students learn how to write their own R scripts and functions. Students learn how to extract data from web sites and bring the input into a shape (e.g. using regular expressions) that is suitable for further analysis. Much of the course will focus on R's graphics features, including network representations and geographic maps. The objective is to present data in ways that are informative, elegant and fun (e.g. as short animated video clips).

Monte Carlo Simulations in Science and Statistics
Yale-NUS College (2017)

Monte Carlo simulations are computer experiments that solve numerical problems by using random number generators. At first glance, it may seem bizarre to use a computer, arguably the most accurate and deterministic of all human inventions, to perform random experiments. However, Monte Carlo simulations are nowadays an essential component in many quantitative studies. They are used in the natural sciences, industrial engineering, finance and statistics. This course teaches how to write elegant and efficient Monte Carlo simulations for concrete real-world examples. Students also learn the theoretical foundations of pseudorandom number generators, Markov chain Monte Carlo and the Metropolis-Hastings algorithm.

Stochastic Processes and Models
Yale-NUS College (2017, 2016)

What do stock markets, the weather, genetic mutations and the movements of a drunkard have in common? All these phenomena are subject to a certain degree of randomness. Such "stochastic processes" are a vibrant area of interdisciplinary research, ranging from mathematical finance over biology to predicting waiting times in supermarket queues. In this course, students learn the mathematics behind the most common models of stochastic processes: Markov chains, Poisson and renewal processes, queuing theory. Students learn how to prove the most important mathematical results and apply them to realistic problems.

Quantitative Reasoning
Yale-NUS College (2017, 2016)

This "Common Curriculum" course aims to develop the students' skills in logical and statistical reasoning so that they become critical and informed readers of quantitative data. The course applies the pedagogy of team-based learning to ensure that students who bring diverse talents and backgrounds to the course can learn together and from each another. Students learn to criticise and question empirical claims, support them with logical arguments and address real-life problems by gathering and visually representing quantitative data. The course teaches quantitative literacy so that students grasp how algorithmic and statistical thinking is used in the natural and social sciences.

Evolutionary Game Theory
Eötvös Loránd University, Budapest (2014)

Game theory is the branch of mathematics that describes how self-interested players choose between several options when the outcome depends not only on their own decision, but also on the choices made by others. "Games" in this mathematical sense may indeed be games in the usual sense of the word (e.g. poker, sports). However, game theory also applies to situations that we would not usually call games, such as auctions or armed conflicts. In evolutionary biology, game theory can even explain phenomena where nobody is overtly making any decisions. In this course, students learn basic concepts of evolutionary game theory: payoff matrix, pure and mixed strategies, different notions of equilibria and their stability.

Engineering Mathematics
University of Bristol (2013)

This two-semester course aims to bring all students entering the Faculty of Engineering up to a common standard in mathematics. The unit contains the well recognised elements of classical engineering mathematics which universally underpin the formation of the professional engineer. Topics include algebra, analysis, calculus, differential equations, probability and statistics.

Teaching experience (ctd.)

Networks: theory and applications
Imperial College London (2011)
This course introduces the mathematical theory of networks with applications to social networks, the Internet, transportation and biology. Topics include graph theory, algorithms and mathematical models of networks, especially random graph models. The objective is to develop the mathematics of network-driven processes (e.g. traffic flows, epidemiology, web search engines) and apply the theory to real data.

I have also taught the following courses.

- *Statistical Computing*, Yale-NUS College (2016)
- *Statistical Programming*, Yale-NUS College (2015)
- *Network flow algorithms*, University of Bristol (2012)
- *PhD school "Networks and medical imaging"*, University of Namur, Belgium (2012)
- *Stochastic spatial models in ecology*, Imperial College London (2012)
- *Mathematics I for Civil Engineers*, Imperial College London (2012)
- *Networks Winter School*, University of Warwick (2011)
- *Biological Modelling*, Universität Oldenburg, Germany (2008)
- *Graduate Workshop in Social Science*, Santa Fe Institute, USA (2006)
- Graduate Student Instructor, University of Michigan (2001–2003)
  - Introductory Mechanics and Sound Laboratory
  - Introductory Electricity and Light Laboratory
  - Elementary Laboratory II (Electricity and Magnetism)

Awards, Honors, Grants and Fellowships

Yale-NUS Research Cluster Seminar Grant 2016
S$20,000 support for workshops and conferences

FP7 Marie Curie Fellowship 2013-2015
competitive intra-European fellowship (total support: €184,000)

Building Global Engagements in Research 2012-2013
competitively awarded internal responsive mode funding at the University of Bristol (£3440 travel award)

Imperial College Junior Research Fellowship 2009-2012
independent fellowship that aims to select world-class early-career researchers through a rigorous three-stage review process in open competition (total support: £122,000)

Computational Science Fellowship of the German Volkswagen Foundation 2009
independent fellowship that supports junior researchers in theoretical and computer-based disciplines, selected by an international review panel (total support: €201,000)

Postdoctoral Fellowship, Santa Fe Institute 2005-2008
highly competitive fellowship that aims to "prepare fellows to be leaders in transdisciplinary science" (salary + $12,000 research expenses)

Awards, Honors, Grants and Fellowships (ctd.)

Rackham Dissertation Grant 2005
awarded by the University of Michigan for exceptionally promising PhD dissertation projects (tuition fees + monthly stipend)

Wirt and Mary Cornwell Prize 2004
awarded to PhD students who have "demonstrated greatest intellectual curiosity, given most promise of original study and creative work" ($10,000 cash award)

Max Kade Foundation Scholarship 2000-2001
competitive fellowship to promote German-US educational exchange (tuition fees + monthly stipend)

Invited positions

Dec 2018 – Oct 2018	Hungarian Academy of Sciences (Budapest): Visiting Senior Research Fellow *Centre for Social Sciences, RECENS research group*
May 2008 – Jan 2008	University of New Mexico (USA): Visiting Postdoctoral Researcher *Department of Computer Science*

Mentoring of student theses

Yale-NUS College (Capstone theses)

- Adam Y. M. Tonks: Reducing Regional Distortions in Flow-based Algorithm Cartograms (2018)
- Evan Asava Aree: A Simulation Model and Web App as a Research and Pedagogical Tool to Understand Succession in Secondary Forests (2018)
- Anna Evtushenko: Networks of Interlocking Directorates, a Global Approach (2017)

Imperial College London (Master of Science theses)

- Elias Bamis: Constrained gravity models for network flows (2012)
- Vivien Seguy: Cartograms (2011)
- Ahmed-Amine Homman: Percolation thresholds on correlated lattices and finite-size scaling (2011)

Invited Presentations in the last 5 years

Dec 2018	*A fast flow-based algorithm for creating density-equalizing map projections* 3rd Asia-Pacific Conference on Complex Systems Design and Management, Singapore.
Oct 2018	*Consensus time in a voter model with concealed and publicly expressed opinions* Seminar, "Lendület" Research Center for Educational and Network Studies (RECENS), Hungarian Academy of Sciences, Budapest
Oct 2018	*Voter model with concealed and publicly expressed opinions* Complexity & Networks Group, Imperial College London

Invited Presentations in the last 5 years (ctd.)

Jan 2018	*A fast flow-based algorithm for creating density-equalizing map projections* Complexity Community Sharing Session, Nanyang Technological University, Singapore.
Dec 2017	*A fast flow-based algorithm for creating density-equalizing map projections* Seminar, Complexity Science Hub Vienna, Austria.
Jul 2016	*Density-equalizing map projections - the past, the present and the future* Workshop on cities as complex systems, Herrenhausen Palace, Hannover, Germany.
May 2015	*How to find communities in networks* Biological Physics Seminar, Eötvös Loránd University, Budapest, Hungary.
Apr 2015	*How to find communities in networks* Informatics Seminar, University of Kyoto, Japan.
Mar 2015	*How to find communities in networks* Evolutionary Zoology seminar, University of Debrecen, Hungary.
Oct 2014	*The complex network of cargo ship movements and its importance in marine bioinvasion* LINK-group seminar, Semmelweis University, Budapest, Hungary.
Oct 2014	*Network formation and decision making* Department of Business Administration, Universität Zürich, Switzerland.
Jun 2014	*The complex network of cargo shipping and its importance in marine bioinvasion* International Workshop on Maritime Networks in Space and Time, Institut des Systèmes Complexes, Paris, France.
Mar 2014	*Gradient percolation – an introduction and recent developments* Nyíregyházi Főiskola Matematika és Informatika Intézet, Nyíregyháza, Hungary
Sep 2013	*The complex network of cargo shipping and its importance in marine bioinvasion* International Workshop on Phase Transition, Critical Phenomena and Related Topics in Complex Networks, Hokkaido University, Sapporo, Japan.
Aug 2013	*The complex network of global cargo ship movements* Seminar, London Mathematical Laboratory, London, UK.

Selected Media Coverage

> *Latest @ Yale-NUS* (4 Apr 2018)
> Yale-NUS faculty member and student collaborate on cartographic research
> https://www.yale-nus.edu.sg/newsroom/4-april-2018-yale-nus-faculty-member-and-student-collaborate-on-cartographic-research/

> *Cordis*, European Commission (25 Aug 2016)
> A game theoretic perspective on network dynamics
> https://www.cordis.europa.eu/result/rcn/188386_en.html

> *ARD*, German public television (19 Jun 2014)
> Wissen vor Acht
> http://www.daserste.de/information/wissen-kultur/wissen-vor-acht-natur/sendung/wissen-vor-acht-natur-344.html

> *ZDF*, German public television (3 Jun 2013)
> Deutschland von oben 3: Fluss (beginning at minute 38:00)
> http://www.zdf.de/Terra-X/Deutsche-Gew%C3%A4sser-von-oben-28028250.html

> *Wall Street Journal* (7 May 2013)
> Roving Sea Squirts, Mussels Threaten Top Asian Ports
> http://blogs.wsj.com/chinarealtime/2013/05/07/roving-sea-squirts-mussels-threaten-top-asian-ports/

> *Der Spiegel* (6 May 2013)
> Eingeschleppte Arten: Forscher kartieren Wege der Bioinvasoren
> http://www.spiegel.de/wissenschaft/natur/eingeschleppte-arten-forscher-kartieren-routen-der-bioninvasoren-a-898178.html#ref=rss

> *BBC News* (5 May 2013)
> Scientists map global routes of ship-borne invasive species
> http://www.bbc.co.uk/news/science-environment-22397076

> *The Atlantic* (1 Dec 2008)
> Share the Road
> http://www.theatlantic.com/magazine/archive/2008/12/quick-study/307155/

> *The Economist* (11 Sep 2008)
> Queuing conundrums
> http://www.economist.com/node/12202559

> *The Guardian* (16 Nov 2004)
> The Altered States
> http://www.theguardian.com/world/2004/nov/16/uselections2004.comment

> *Washington Post* (13 Nov 2004)
> Election Map Makers, Exercising Some Latitude
> http://www.washingtonpost.com/wp-dyn/articles/A46719-2004Nov12.html

> *CNN* (12 Nov 2004)
> Paula Zahn Now
> http://edition.cnn.com/TRANSCRIPTS/0411/12/pzn.01.html

Further media coverage in Science, Nature, Scientific American, Los Angeles Times, Die Welt,

Stern and many others.

Referees

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Appendix: Complete Publication List

M. T. Gastner, B. Oborny and M. Gulyás
Consensus time in a voter model with concealed and publicly expressed opinions
J. Stat. Mech. Theory Exp. 2018(6):063401 (2018)
DOI: 10.1088/1742-5468/aac14a

M. T. Gastner, V. Seguy and P. More
Fast flow-based algorithm for creating density-equalizing map projections
Proc. Natl. Acad. Sci. U.S.A. 115(10):E2156–E2164 (2018)
DOI: 10.1073/pnas.1712674115

M. T. Gastner and G. Ódor
The topology of large Open Connectome networks for the human brain
Sci. Rep. 6(6):27249 (2016)
DOI: 10.1038/srep27249

M. T. Gastner
Network formation, statistical physics and social dynamics
Technical Report, CORDIS (European Commission), published online on 17 February 2016
https://cordis.europa.eu/docs/results/327/327325/final1-final_report.pdf

M. T. Gastner and C. Ducruet
The distribution functions of vessel calls and port connectivity in the global cargo ship network
in C. Ducruet (Ed.), *Maritime networks: Spatial structures and time dynamics*, pp. 289-294 (Routledge, London, 2015)
https://www.taylorfrancis.com/books/e/9781317434559

M. T. Gastner
The Ising chain constrained to an even or odd number of positive spins
J. Stat. Mech. Theory Exp. 2015(3):P03004 (2015)
DOI: 10.1088/1742-5468/2015/03/P03004

M. T. Gastner and C. Ducruet
How Heavy-Tailed is the Distribution of Global Cargo Ship Traffic?
10th Int. Conf. Signal-Image Technology & Internet-Based Systems, pp. 289–294 (2014)
DOI: 10.1109/SITIS.2014.33

M. T. Gastner, N. Markou, G. Pruessner and M. Draief
Opinion Formation Models on a Gradient
PLoS ONE 9(12):e114088 (2014)
DOI: 10.1371/journal.pone.0114088

V. Salnikov, D. Schien, H. Youn, R. Lambiotte and **M. T. Gastner**
The geography and carbon footprint of mobile phone use in Cote d'Ivoire
EPJ Data Sci. 3(1):3 (2014)
DOI: 10.1140/epjds21

H. Seebens, **M. T. Gastner** and B. Blasius
The risk of marine bioinvasion caused by global shipping
Ecol. Lett. 16(6):782–790 (2013)
DOI: 10.1111/ele.12111

Appendix: Complete Publication List (ctd.)

M. T. Gastner and B. Oborny
The geometry of percolation fronts in two-dimensional lattices with spatially varying densities
New J. Phys. 14(10):103019 (2012)
DOI: 10.1088/1367-2630/14/10/103019

M. T. Gastner
Scaling and entropy in p-median facility location along a line
Phys. Rev. E 84(3):036112 (2011)
DOI: 10.1103/PhysRevE.84.036112

M. T. Gastner, B. Oborny, A. B. Ryabov and B. Blasius
Changes in the Gradient Percolation Transition Caused by an Allee Effect
Phys. Rev. Lett. 106(12):128103 (2011)
DOI: 10.1103/PhysRevLett.106.128103

P. Kaluza, A. Kölzsch, **M. T. Gastner** and B. Blasius
The complex network of global cargo ship movements
J. Royal Soc. Interface 7(48):1093-1103 (2010)
DOI: 10.1098/rsif.2009.0495

M. T. Gastner
Traffic flow in a spatial network model
in A. Minai, D. Braha and Y. Bar-Yam (Eds.), *Unifying Themes in Complex Systems*, pp. 315-322 (Springer, Berlin, 2010)
DOI: 10.1007/978-3-540-85081-6_40

M. T. Gastner, B. Oborny, D. K. Zimmermann and G. Pruessner
Transition from Connected to Fragmented Vegetation across an Environmental Gradient: Scaling Laws in Ecotone Geometry
Am. Nat. 174(1):E23–E39 (2009)
DOI: 10.1086/599292

H. Youn, **M. T. Gastner** and H. Jeong
Inefficiency in Networks with Multiple Sources and Sinks
in J. Zhou (Ed.), *Complex Sciences*, pp. 334–338 (Springer, Berlin, 2009)
DOI: 10.1007/978-3-642-02466-5_32

H. Youn, **M. T. Gastner** and H. Jeong
Price of Anarchy in Transportation Networks: Efficiency and Optimality Control
Phys. Rev. Lett. 101(12):128701 (2008)
DOI: 10.1103/PhysRevLett.101.128701

M. T. Gastner
Shape and efficiency in growing spatial distribution networks
2nd Eur. Conf. Complex Systems, pp. 82 (2006)
http://www.cabdyn.ox.ac.uk/complexity_PDFs/ECCS06/Conference_Proceedings/PDF/p82.pdf

M. T. Gastner and M. E. J. Newman
Optimal design of spatial distribution networks
Phys. Rev. E 74(1):016117 (2006)
DOI: 10.1103/PhysRevE.74.016117

Appendix: Complete Publication List (ctd.)

M. T. Gastner and M. E. J. Newman
The spatial structure of networks
Eur. J. Phys. B 49(2):247–252 (2006)
DOI: 10.1140/epjb/e2006-00046-8

M. T. Gastner and M. E. J. Newman
Shape and efficiency in spatial distribution networks
J. Stat. Mech. Theory Exp. 2006(1):P01015 (2006)
DOI: 10.1088/1742-5468/2006/01/P01015

M. T. Gastner
Spatial distributions: Density-equalizing map projections, facility location, and two-dimensional networks
Ph.D. dissertation, Univ. Michigan (Ann Arbor, 2005)
https://deepblue.lib.umich.edu/handle/2027.42/125368

M. T. Gastner and M. E. J. Newman
Density-equalizing map projections: Diffusion-based algorithm and applications
8th Int. Conf. GeoComputation (2005)
http://www.geocomputation.org/2005/

M. T. Gastner, C. R. Shalizi and M. E. J. Newman
Maps and cartograms of the 2004 US presidential election results
Adv. Complex Syst. 8(1):117–123 (2005)
DOI: 10.1142/S0219525905000397

M. T. Gastner and M. E. J. Newman
Diffusion-based method for producing density-equalizing maps
Proc. Natl. Acad. Sci. U.S.A 101(20):7499–7504 (2004)
DOI: 10.1073/pnas.0400280101