Shai Revzen

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Education

2020 (exp. 2023) **J.D.**, *Wayne State Univ.*, Detroit.
Law

2003 Dec 2009 **Ph.D.**, *Univ. California*, Berkeley.
Integrative Biology

1994 Jun 2002 **M.Sc.**, *Hebrew Univ.*, Jerusalem.
Computer Science (Optimization)

1989 May 1993 **B.Sc.**, *Hebrew Univ.*, Jerusalem, *Magna cum laude*.
Degree from honours program; Majors Computer Science, Math (extended); Minor Physics

Doctoral thesis

title Neuromechanical Control Architectures in Arthropod Locomotion
supervisor Robert J. Full

Master thesis

title Paging on Access Graphs of Minimal Degree 3
supervisor Nati Linial

Work Experience

Academia

19–now **Associate Professor**, *U. Michigan (Ecology and Evolutionary Biology)*, Ann Arbor.
Research, student supervision; biomechanics and mathematical biology

19–now **Associate Professor**, *U. Michigan (Electrical Engineering and Computer Science)*, Ann Arbor.
Research, student supervision; robotics and control theory

12–19 **Assistant Professor**, *U. Michigan (Ecology and Evolutionary Biology)*, Ann Arbor.
Research, student supervision; biomechanics and mathematical biology

12–19 **Assistant Professor**, *U. Michigan (Electrical Engineering and Computer Science)*, Ann Arbor.
Research, student supervision; robotics and control theory

11–12 **Visiting Assistant Professor**, *U. Michigan (Electrical Engineering and Computer Science)*.

09–12 **Postdoctoral Research Associate**, *U. Pennsylvania*, Philadelphia.
Research, student supervision; robotics and control theory
Advisors Mark Yim, Daniel E. Koditschek and George Pappas

06–09 **Graduate Student Researcher**, *U. California*, Berkeley.
Funded Ph.D. research; biomechanics

Tech Industry

19–now **General Manager**, *Izun, Inc.*, Pittsfield, MI USA.
Technology Consulting and Education

22–now **Chief Science Officer**, *Acculine Medical*, Petach Tiqva, ISRAEL.
Biomedical Diagnostic Device start-up

03–22 **Founding partner**, *Bio-Signal Analysis*, Tel-Aviv, ISRAEL.
Technology start-up

01–06 **Chief Architect, R&D**, *Harmonic, Inc.*, Sunnyvale, CA, USA.
R&D, embedded programming, algorithms; Company develops digital video equipment for cable and satellite

98–01 **Chief Architect**, *Harmonic Data, Ltd.*, Tel-Aviv, ISRAEL.
Company-wide system architecture, basic research team manager, academic liaison; Company develops Internet over satellite solutions

96–98 **Instructor**, *John Bryce Training*, Ramat-Gan, ISRAEL.
Teaching Java, Javascript, HTML; Company trains IT professionals

97 **Software Engineer**, *Compedia, Ltd*, Ramat-Gan, ISRAEL.
Design and development of 3D video game engine; Company develops edutainment products for kids

Military Service (Israel)

96–17 **Reserve duty**, *IDF*.

93–96 **Mandatory service**, *IDF*.

Publications and Other Products

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Papers

[Rev23] S Revzen. "Contract Drafting, Programming Languages, and what they can teach each other". In: *Wayne State Journal of Business Law* (2023).

[Zha+22] D Zhao, B A Bittner, G Clifton, N Gravish, and Revzen S. "Walking is like slithering: A unifying, data-driven view of locomotion". In: *Proceedings of the National Academy of Science* (2022). (IN PRINT). DOI: 10.1073/pnas.2113222119.

[CRB21] G Council, S Revzen, and S A Burden. "Representing and computing the B-derivative of an EC^r vector field's PC^r flow". In: *J Comput Nonlinear Dynam* (2021). ACCEPTED. DOI: 10.1115/1.4054481. arXiv: 2102.10702. URL: [LINK].

[WBR21a] Z Wu, S L Brunton, and S Revzen. "Challenges in Dynamic Mode Decomposition". In: *J of The Royal Society Interface* 18 (2021), p. 20210686. DOI: 10.1098/rsif.2021.0686.

[BHR20a] B Bittner, R L Hatton, and S Revzen. "Data-Driven Geometric System Identification for Shape-Underactuated Dissipative Systems". In: *Bioinspiration and Biomimetics* 17 (2020), p. 026004. DOI: 10.1088/1748-3190/ac3b9c.

[ZR20] D Zhao and S Revzen. "Multi-legged steering and slipping with low DoF hexapod robots". In: *Bioinspiration and Biomimetics* 15.4 (2020), p. 045001. DOI: 10.1088/1748-3190/ab84c0.

[KBS19] M Kvalheim, B Bittner, and Revzen S. "Gait modeling and optimization for the perturbed Stokes regime". In: *J Nonlinear Dynamics* (2019). DOI: 10.1007/s11071-019-05121-3.

[WZR19] Ziyou Wu, Dan Zhao, and Shai Revzen. "Coulomb Friction Crawling Model Yields Linear Force–Velocity Profile". In: *J Applied Mechanics* 86.5 (2019). DOI: 10.1115/1.4042696.

[BHR18] B A Bittner, R A Hatton, and S Revzen. "Geometrically Optimal Gaits: a Data-Driven Approach". In: *Nonlinear Dynamics* 94.3 (2018), pp. 1933–1948. DOI: 10.1007/s11071-018-4466-9.

[EKR18] J Eldering, M Kvalheim, and S Revzen. "Global linearization and fiber bundle structure of invariant manifolds". In: *Nonlinearity* 31.9 (2018). Ed. by Rafael de la Llave, p. 4202. DOI: 10.1088/1361-6544/aaca8d.

[Fit+17] I Fitzner, Y Sun, V Sachdeva, and S Revzen. "Rapidly Prototyping Robots: Using Plates and Reinforced Flexures". In: *IEEE Robotics Automation Magazine* 24.1 (Mar. 2017), pp. 41–47. ISSN: 1070-9932. DOI: 10.1109/MRA.2016.2639058.

[RK17] S Revzen and D E Koditschek. "Why we need more degrees of freedom". In: *Procedia IUTAM* 20 (2017). 24th International Congress of Theoretical and Applied Mechanics, pp. 89–93. ISSN: 2210-9838. DOI: https://doi.org/10.1016/j.piutam.2017.03.012.

[Wil+17a] S Wilshin, G C Haynes, J Porteous, D E Koditschek, S Revzen, and A J Spence. "Morphology and the gradient of a symmetric potential predict gait transitions of dogs". In: *Biological Cybernetics* 111.3 (2017), pp. 269–277. ISSN: 1432-0770. DOI: 10.1007/s00422-017-0721-2.

[Wil+17b] S Wilshin, M A Reeve, G C Haynes, S Revzen, D E Koditschek, and A J Spence. "Longitudinal quasi-static stability predicts changes in dog gait on rough terrain". In: *Journal of Experimental Biology* 220.10 (2017), pp. 1864–1874. ISSN: 0022-0949. DOI: 10.1242/jeb.149112.

[Bur+16] S A Burden, S S Sastry, D E Koditschek, and S Revzen. "Event-Selected Vector Field Discontinuities Yield Piecewise-Differentiable Flows". In: *SIAM Journal of Applied Dynamical Systems* 15.2 (2016), pp. 1227–1267. DOI: 10.1137/15M1016588.

[BRS15] S A Burden, S Revzen, and S S Sastry. "Model reduction near periodic orbits of hybrid dynamical systems". In: *IEEE Transactions on Automatic Control* 60.10 (2015), pp. 2626–2639. DOI: 10.1109/TAC.2015.2411971.

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Preprints

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[BR21] Brian Bittner and Shai Revzen. "Optimizing Gait Libraries via a Coverage Metric". 2021. arXiv: 2107.08775. URL: [LINK].

[GR21] Sandilya Sai Garimella and Shai Revzen. "Dandelion-Picking Legged Robot". 2021. arXiv: 2112.05383. URL: [LINK].

[WKR21] Simon Wilshin, Matthew D Kvalheim, and Shai Revzen. "Phase Response Curves and the Role of Coordinates". 2021. arXiv: 2111.06511. URL: [LINK].

[BHR20b] B Bittner, R L Hatton, and S Revzen. "Data-Driven Geometric System Identification for Shape-Underactuated Dissipative Systems". 2020. arXiv: 2012.11064. URL: [LINK].

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[KR16b] Matthew Kvalheim and Shai Revzen. "Reverse-engineering invariant manifolds with asymptotic phase". 2016. arXiv: 1608.08442. URL: [LINK].

[RB16] S Revzen and S A Burden. "Computing the Bouligand derivative of a class of piecewise-differentiable flows". 2016. arXiv: 1612.02763. URL: [LINK].

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[BRS13b] S A Burden, S Revzen, and S S Sastry. "Model reduction near periodic orbits of hybrid dynamical systems". English. 2013. arXiv: 1308.4158. URL: [LINK].

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Other Products

[WR23] Ziyou Wu and Shai Revzen. "Connection-Based Data-Driven Gait Modeling of a Quadruped". In: *APS March Meeting Abstracts*. APS, 2023.

[AR22] Marion Anderson and Shai Revzen. "Simultaneous Leg Impacts Lead to a Differentiable Flow". In: *APS March Meeting Abstracts*. Vol. 2022. 2022, W03–007.

[DWR22] Advait Deshpande, Ziyou Wu, and Shai Revzen. "Accelerating multi-contact modeling using a GPU". In: *APS March Meeting Abstracts*. Vol. 2022. 2022, W03–011.

[WR22] Ziyou Wu and Shai Revzen. "Why does a viscous friction ansatz give accurate multi-contact coulomb friction predictions". In: *APS March Meeting Abstracts*. Vol. 2022. 2022, W03–002.

[BIR21a] BIRDS-Lab. *BigAnt v6 robot motion tracking data - processed dataset*. Deepblue Data Repository. Aug. 2021. DOI: 10.7302/jh82-fh69.

[BIR21b] BIRDS-Lab. *BigAnt v6 robot motion tracking data - RAW dataset*. Deepblue Data Repository. Aug. 2021. DOI: 10.7302/024q-kk06.

[BIR21c] BIRDS-Lab. *BIRDS Lab Multipod robot motion tracking data - processed data and code*. Deepblue Data Repository. Oct. 2021. DOI: 10.7302/0fpj-dz57.

[BIR21d] BIRDS-Lab. *BIRDS Lab Multipod robot motion tracking data - RAW dataset*. Deepblue Data Repository. Oct. 2021. DOI: 10.7302/m05a-0d90.

[BIR21e] BIRDS-Lab. *BIRDS Lab Multipod robot motion tracking data - videos*. Deepblue Data Repository. Oct. 2021. DOI: 10.7302/1y3q-1b42.

[BIR21f] BIRDS-Lab. *Walking Like a Worm : dataset and figures*. Deepblue Data Repository. Aug. 2021. DOI: 10.7302/gqk6-3x41.

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[Rev+21a] S Revzen, D Zhao, B Bittner, G Clifton, and N Gravish. "Bridging Walking and Slithering - Stokesian Locomotion". In: *Dynamic Walking*. extended abstract and poster. Dynamic Walking. 2021. DOI: 10.7302/4322.

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[WBR21b] Ziyou Wu, S L Brunton, and S Revzen. *Challenges in Dynamic Mode Decomposition – figures*. Deepblue Data Repository. Aug. 2021. DOI: 10.7302/nzq9-4715.

[Zha21] D Zhao. "Locomotion of low-DOF multi-legged robots". PhD thesis. University of Michigan, 2021. DOI: 10.7302/3030.

[BR20] B A Bittner and S Revzen. "A Robot Made of Tree Branches Can Learn to Move in 15 Minutes". In: *Dynamic Walking*. Dynamic Walking. Internet, June 2020. URL: [LINK].

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[CR20b] George Council and Shai Revzen. "Recovery of Behaviors of Robots without Dynamics". In: American Physical Society, 2020. URL: [LINK].

[M A20] S Revzen M Anderson T McLaughlin. "Serial Elastic versus Parallel Elastic Actuators in Hopping". In: *Dynamic Walking*. 513. Dynamic Walking. Internet, June 2020. URL: [LINK].

[MAR20a] T. McLaughlin, M. Anderson, and S. Revzen. *Hopping with Elastic Restitution Is More Difficult Than It Seems*. URL. 2020.

[MAR20b] Taylor McLaughlin, Marion Anderson, and Shai Revzen. "Hopping with Elastic Restitution Is More Difficult Than It Seems". In: American Physical Society, 2020. URL: [LINK].

[Rev20a] S Revzen. *From slithering, to swimming, to walking : a journey of geometric mechanics*. U Michigan Applied Physics Seminar. Dec. 2020. URL: [LINK].

[Rev20b] S Revzen. *How the physics of slithering can teach multilegged robots to walk*. U Michigan Saltiel Life Sciences Seminar. Sept. 2020. URL: [LINK].

[Rev20c] S Revzen. *Kahn Autonomous Systems Mega-Project Annual Meeting (organizer)*. Kahn Foundation Annual Meeting. Dec. 2020. URL: [LINK].

[S20a] Revzen S. *How walking is a lot like slithering*. U Michigan EEB Department Seminar. Nov. 2020. URL: [LINK].

[S20b] Revzen S. *Recovering from robot failures by very fast learning*. U Cal Santa-Cruz CPSRC Seminar. Nov. 2020. URL: [LINK].

[S20c] Revzen S. *Two approaches to make robots robustly recover from failure*. University of Washington Mechanical Engineering Seminar. Jan. 2020.

[Sar+20] A Sarin, D Abbot, S Revzen, and A-T Avestruz. "Bidirectional Capacitive Wireless Power Transfer for Energy Balancing in Modular Robots". In: *Applied Power Electronics Conference and Exposition*. IEEE, 2020, pp. 852–859. DOI: 10.1109/APEC39645.2020.9124139.

[BR19] B Bittner and S Revzen. "Optimizing Gaits for Coverage on Lie Groups". In: *Dynamic Walking*. Dynamic Walking. June 2019. URL: [LINK].

[Cou19] G Council. "Data Driven Methods to Build Robust Legged Robots". PhD thesis. University of Michigan, 2019. URL: [LINK].

[CR19] G Council and S Revzen. "Energy and Phased Based Movement Recovery". In: *2019 SIAM Conference on Dynamical Systems*. SIAM. Snowbird, UT, 2019. URL: [LINK].

[KBR19] M Kvalheim, B Bittner, and S Revzen. "Reduced-Order Models for Locomotion in the Perturbed Stokes Regime". In: *2019 SIAM Conference on Dynamical Systems*. SIAM. Snowbird, UT, 2019. URL: [LINK].

[KR19a] M Kvalheim and S Revzen. "Hybrid Oscillators: Phase and Amplitude in a Class of Non-Smooth Systems". In: *2019 SIAM Conference on Dynamical Systems*. SIAM. Snowbird, UT, 2019. URL: [LINK].

[KR19b] M Kvalheim and S Revzen. "Principal Koopman Eigenfunctions for Nonlinear and Nonsmooth Systems". In: *IPAM workshop: Operator Theoretic Methods in Dynamic Data Analysis and Control*. (poster). UCLA, Feb. 2019.

[Rev19a] S Revzen. *How many legs become a snake?* CMU Mechanical Engineering Seminar. July 2019.

[Rev19b] S Revzen. "Moving with more legs is different: a geometric mechanics perspective". In: *Integrative and comparative biology*. Vol. 59. 2019, E191–E191.

[Rev19c] S Revzen. *Three legs to stand on: vignettes from the study of locomotion*. AIM Program Seminar. Feb. 2019. URL: [LINK].

[RCK19] S Revzen, G Council, and M Kvalheim. "Is Legged Locomotion Almost Smooth?" In: *Dynamic Walking*. 446. Dynamic Walking. Canmore AB, CA, June 2019. URL: [LINK].

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[ZLR19] D Zhao, H Li, and S Revzen. "Design and Undulatory Gait Tests of a Meter-size Modular Centipede Robot". In: *Dynamic Walking*. 503. Dynamic Walking. Canmore AB, CA, June 2019. URL: [LINK].

[B B18b] S Revzen B Bittner R Hatton. "Step Selection in Data-Driven Geometric Gait Optimization". In: *American Physical Society March Meeting*. 2018.

[BR18a] B Bittner and S Revzen. "The Locality of Data-Driven Models". In: *Dynamic Walking*. 2018.

[BR18b] B Bittner and S Revzen. “What do nematode swimming gaits optimize?” In: *Yearly Meeting of the Society for Integrative and Comparative Biology*. 2018.

[KER18] M Kvalheim, J Eldering, and S Revzen. “Global linearization and fiber bundle structure of invariant manifolds”. In: *AIMS*. 2018. URL: [LINK].

[KR18a] M Kvalheim and S Revzen. “Templates and Anchors: a review of notions of model reduction”. In: *Dynamic Walking*. 2018. URL: [LINK].

[KR18b] M Kvalheim and S Revzen. “Testing an extended "Posture Principle"”. In: *Integrative and Comparative Biology*. SICB. 2018. URL: [LINK].

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[BR17] B Bittner and S Revzen. “Geometric Insights for Data-Driven Gait Analysis”. In: *IEEE International Conference On Intelligent Robots and Systems, Workshop on Robotics Inspired Biology*. 2017. URL: [LINK].

[CR17a] G Council and S Revzen. “Gait Synthesis with Reduced Proprioceptive Requirements”. In: *IEEE International Conference On Intelligent Robots and Systems, Workshop on Robotics Inspired Biology*. 2017. URL: [LINK].

[CR17b] G Council and S Revzen. “Limb Coordination with Reduced Priopriocepive Requirements via Event-Selected Dynamics”. In: *MBI workshop 4: Sensori-Motor Control of Animals and Robots*. 2017. URL: [LINK].

[KR17a] M Kvalheim and S Revzen. “A dynamical systems perspective on Templates & Anchors: some general methods for anchoring templates”. In: *IEEE International Conference On Intelligent Robots and Systems, Workshop on Robotics Inspired Biology*. 2017. URL: [LINK].

[KR17b] M Kvalheim and S Revzen. “Asymptotic phase, model reduction, and control of Templates Anchors”. In: *MBI workshop 4: Sensori-Motor Control of Animals and Robots*. 2017. URL: [LINK].

[RR17] S Ramasamy R Hatton B Bittner and S Revzen. “Data-driven geometric gait analysis”. In: *Dynamic Walking*. 2017. URL: [LINK].

[Rev17a] S Revzen. “In defense of Aristotle: is there a Connection for multi-legged locomotion?” In: *MBI workshop 4: Sensori-Motor Control of Animals and Robots*. 2017. URL: [LINK].

[Rev17b] S Revzen. *Morphologically Modulated Dynamics*. ARO & ONR Bio-inspired Autonomous Systems Workshop. June 2017.

[Rev17c] S Revzen. *Seeking Simple Models for Multilegged Locomotion Hybrid Oscillators, Rapid Manufacturing, and Slippage*. Ben-Gurion University, ISRAEL. May 2017.

[Rev17d] S Revzen. *Seeking Simple Models for Multilegged Locomotion Hybrid Oscillators, Rapid Manufacturing, and Slippage*. Technion, ISRAEL. May 2017.

[Rev17e] S Revzen. “When do locomotor appendages get complicated?” In: *Integrative and comparative biology*. Vol. 57. 2017, E385.

[RH17] S Revzen and R Hatton. “Phase Helps Find Geometrically Optimal Gaits”. In: *Bulletin of the APS*. X12.00008. 2017. URL: [LINK].

[V S17] S Revzen V Sachdva D Zhao. “Slipping Matters”. In: *Dynamic Walking*. 2017.

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[Ban+16] B Banjanin, SA Burden, TY Moore, S Revzen, and RJ Full. "Estimating predictive dynamical models of legged locomotion from data". In: *Integrative and comparative biology*. Vol. 56. 2016, E11–E11.

[CR16] G Council and S Revzen. "Recovering a gait using energy and phase". In: *Dynamic Walking*. 2016.

[KR16a] M Kvalheim and S Revzen. "Bioinspired Legged Locomotion". In: ed. by M Sharbafi and A Seyfarth. Elsevier, 2016. Chap. Templates and Anchors, Chapter 3.2, pp. 62–78. ISBN: 978-0-12-803766-9. DOI: 10.1016/B978-0-12-803766-9.00004-X.

[Rev16a] S Revzen. *(invited presentation ARO workshop)*. ARO workshop on The Future of Vibration Energy Transfer in Solids and Structures Needs and Opportunities Workshop. 2016.

[Rev16b] S Revzen. *(invited presentation ONR workshop)*. ONR workshop on Distributed Sensing, Actuation, and Control for Bioinspired Soft Robotics. Oct. 2016.

[Rev16c] S Revzen. *A Few Reasons Why I Love Legs*. Ann Arbor Nerd Night Talk. June 2016. URL: [LINK].

[Rev16d] S Revzen. *Seeking Simple Models for Multilegged Locomotion Hybrid Oscillators, Rapid Manufacturing, and Slippage*. University of California Berkeley. Jan. 2016.

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[Rev14] S Revzen. "Lessons from animal locomotion: extending Floquet theory to hybrid limit cycle oscillators". In: *Annual meeting of the SIAM*. MS8: Locomotion in Terrestrial and Granular Environments. 2014.

[RBK14] S Revzen, SA Burden, and MD Kvalheim. "Why the trot?" In: *Integrative and comparative biology*. Vol. 54. 2014, E174–E174.

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