

# Raphaël J. L. Townshend

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**Research interests**   Machine Learning, Structural Biology, Biophysics  
Computer Vision, High-Performance Computing

**Education**   **Stanford University**   Sept 2014 – Dec 2020  
PhD in Computer Science (Artificial Intelligence)  
GPA: 4.00.

**University of California, Berkeley**   Sept 2010 – May 2014  
BS in Electrical Engineering and Computer Science (High Distinction)  
GPA: 3.90

- Peer-reviewed publications**
- Learning from Protein Structure with Geometric Vector Perceptrons**  
B. Jing\*, S. Eismann\*, P. Suriana, R.J.L. Townshend, R.O. Dror.  
*International Conference on Learning Representations (ICLR), 2021.*
- Hierarchical, rotation-equivariant neural networks to select structural models of protein complexes**  
S. Eismann\*, R.J.L. Townshend\*, N. Thomas\*, M. Jagota, B. Jing, R.O. Dror.  
*Proteins, 2020.*
- How GPCR phosphorylation patterns orchestrate arrestin-mediated signaling**  
N.R. Latorraca\*, M. Masureel<sup>†</sup>, S.A. Hollingsworth, F.M. Heydenreich, C.-M. Suomivuori, C. Brinton, R.J.L. Townshend, M. Bouvier, B.K. Kobilka, R.O. Dror<sup>†</sup>.  
*Cell, 2020.*
- End-to-End Learning on 3D Protein Structure for Interface Prediction**  
R.J.L. Townshend, R. Bedi, P.A. Suriana, and R.O. Dror.  
*Neural Information Processing Systems (NeurIPS), 2019.*
- Molecular Mechanism of GPCR-Mediated Arrestin Activation**  
N.R. Latorraca, J.K. Wang, B. Bauer, R.J.L. Townshend, S.A. Hollingsworth, J.E. Olivieri, H.E. Xu, M.E. Sommer<sup>†</sup>, and R.O. Dror<sup>†</sup>.  
*Nature, 2018.*

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\* equal contribution

<sup>†</sup> co-corresponding

## **User-Driven Geolocation of Untagged Desert Imagery Using Digital Elevation Models**

E. Tzeng, A. Zhai, M. Clements, R.J.L. Townshend, and A. Zakhor.

*Computer Vision and Pattern Recognition Workshops (CVPRW), 2013.*

### **Preprints**

## **Geometric Deep Learning of RNA Structure**

R.J.L. Townshend<sup>\*</sup>, S. Eismann<sup>\*</sup>, A. Watkins<sup>\*</sup>, R. Rangan, R. Das<sup>†</sup>, R.O. Dror<sup>†</sup>.

*In review.*

## **ATOM3D: Tasks On Molecules in Three Dimensions**

R.J.L. Townshend<sup>†</sup>, M. Vogele, P. Suriana, A. Derry, A. Powers, Y. Laloudakis, S. Balachandar, S. Eismann, B.M Anderson, R. Kondor, R. Altman, R.O. Dror<sup>†</sup>.

*arXiv:2012.04035*

## **Geometric Prediction: Moving Beyond Scalars**

R.J.L. Townshend, B. Townshend, S. Eismann, R.O. Dror.

*arXiv:2006.14163*

## **Protein model quality assessment using rotation-equivariant, hierarchical neural networks**

S. Eismann<sup>\*</sup>, P. Suriana<sup>\*</sup>, B. Jing , R.J.L. Townshend, R.O. Dror.

*arXiv:2011.13557*

## **Gold nanoparticles and tilt pairs to assess protein flexibility by cryo-electron microscopy**

M. Jagota, R.J.L. Townshend, L.W. Kang, D. Bushnell, R.O. Dror, R.D. Kornberg, M. Azubel.

*In review.*

## **Simple biochemical features underlie transcriptional activation domain diversity and dynamic, fuzzy binding to Mediator**

A.L. Sanborn, B.T. Yeh, J.T. Feigerle, C.V. Hao, R.J.L. Townshend, E. Lieberman Aiden, R.O. Dror, R.D. Kornberg.

*bioRxiv:2020.12.18.423551*

### **Honors and scholarships**

Science Graduate Student Research Program (Department of Energy)	2019
Graduate Research Fellowship Program (National Science Foundation)	2015
Best in Show and People's Choice (Science Hack Day SF)	2013/2015
School of Engineering Graduate Fellowship (Stanford)	2014
ACM International Collegiate Programming Contest (UC Berkeley)	2013
EECS Honors Degree, Statistical Learning concentration (UC Berkeley)	2013
Maker Faire Young Inventor	2010

Research experience	<b>Stanford Artificial Intelligence Laboratory</b>	Stanford University
	Advisor: Dr. Ron Dror (Stanford University)	09/2014 – Present
	Thesis on geometric learning of biomolecular structure. Leading interdisciplinary team of 1 postdoc, 2 graduate students, and several undergraduates. Developed state-of-the-art methods for predicting protein interactions. Designed an equivariant graph neural network for predicting the 3D structure of RNA, which has consistently won international blind prediction competitions.	
	<b>Video and Image Processing Laboratory</b>	UC Berkeley
	Advisor: Dr. Avideh Zakhor	05/2012 – 06/2014
	Developed Computer Vision techniques for large-scale geo-localization. Created a synthetic horizon matcher using digital elevation models. Achieved 8000x speed-up as compared to previously used techniques and produced predictions that were within 100m accuracy within a 10,000 km <sup>2</sup> region.	
Industry experience	<b>DeepMind, AlphaFold</b>	London, UK
	Research Scientist Intern	Summer 2019
	Pursued new research in artificial intelligence and structural biology. First inventor on pending patent based on internship work.	
	<b>Scaled Inference</b>	Palo Alto, CA
	Inference Intern	Summer 2015
	Designed and implemented Bayesian learning algorithms for core modeling pipeline.	
	<b>Google, Knowledge: Search</b>	Mountain View, CA
	Software Engineering Intern	Summer 2014
	Designed algorithms to exploit structured data on the web.	
	<b>Hewlett-Packard, WebOS</b>	Sunnyvale, CA
	Software Engineering Intern	Summer 2011
	Implemented performance improvements within the mobile graphics engine.	
Teaching experience	<b>Head teaching assistant, Computer Science</b>	Stanford University
	CS 279: Computational Biology	Fall 2020
	Led team of 4 teaching assistants, with 100 enrolled students. Designed and lectured new course material on machine learning in structural biology.	
	<i>Average student rating: 4.1/5.</i>	
	<b>Head teaching assistant, Computer Science</b>	Stanford University
	CS 229: Machine Learning	Fall 2018
	Led team of 30 teaching assistants, with 750 enrolled students. Designed and lectured new course material on ensembling methods and decision trees.	

*Average student rating: 4.1/5.*

**DeCal instructor, Carillon Guild**

UC Berkeley

Learn to Play the Sather Tower Bells

Spring 2014

Taught course on how to play the carillon to a dozen undergraduates.

**Undergraduate student instructor, Computer Science**

UC Berkeley

CS 61C: Machine Structures

Summer 2012

Taught section and lab of 30 students. Guest lectured on MapReduce and large-scale computing to class of 100.

**Advisees**

**Martin Vogeles**

Postdoctoral scholar

**Stephan Eismann**

PhD student

**Patricia Suriana**

PhD student

**Bowen Jing**

Undergraduate

**Ligia Melo**

Undergraduate

**David Liu**

Undergraduate

**Yianni Laloudakis**

Now medical student at Columbia

**Milind Jagota**

Now CS PhD student at UC Berkeley

**Rishi Bedi**

Now founder of Y-Trap

**Service and outreach**

**Machine Learning for Structural Biology @ NeurIPS**

12/2020

Devised and led inaugural workshop at premiere machine learning conference. As general chair, organized talks, discussion, and papers by leading researchers in the field. Website at [mlsb.io](http://mlsb.io).

**Open Computing Facility, UC Berkeley**

08/2011 – 06/2014

Served as an administrator and director for computing facility with 7,000 student users. Was sole provider of computing, web hosting, and printing resources for a large fraction of the student population.

**Biographical**

**Citizenship**

Canadian, U.S. Permanent Resident

**Date of Birth**

January 22, 1993 (Montréal, Canada)

**Languages**

English (native), French (native)

**Professional memberships**

**Eta Kappa Nu**

12/2011 – Present

Undergraduate honors society in electrical engineering and computer science.

**Other interests**

Social dance (swing, waltz), carillon, skiing, board games (hanabi, diplomacy).