

## CV : ALEXIS DUBREUIL

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Personal: Born 24th of February 1986, French, 2 children  
Languages: French, English, Italian

### EDUCATION

2014 **PhD in Theoretical Neurosciences, Paris Descartes University, Paris, France**

*(supervisor: Nicolas Brunel ; examiners: Peter Latham, Alessandro Treves)*

Title of the thesis: 'Memory and Cortical Connectivity'.

2007-2011 **Ecole Normale Supérieure de Cachan, Physics Department, Cachan, France**

2007- Bachelor in Physics: from Licence de Sciences et Technologies, Mention Physique (Paris 6 University).

Classes include: statistical physics, numerical physics, quantum physics, electro-dynamics, relativity, lab classes.

2011- Master « Theoretical Physics of Complex Systems »: from Master de Sciences et Technologies, mention Physique et Applications (Paris 6, 7, 11 and ENS Cachan).

Classes include: advanced statistical physics, non-linear dynamics, statistical and quantum field theory, soft matter, advanced course in theoretical neuroscience.

2004-2007 **Classe Préparatoire aux Grandes Ecole, MPSI-PSI, Clermont-Ferrand, France**

Intensive study of Mathematics and Physics.

#### **Others: Machine learning classes**

2018 Deep-learning-do-it-yourself, master level deep learning course at ENS.

2015 L'apprentissage profond, series of lectures by Yan LeCun at Collège de France.

2013 Summer school: Statistical Physics, Optimization, Inference, and Message-Passing Algorithms, in Les Houches.

### RESEARCH EXPERIENCE

02/2018-present **Group for Neural Theory, Ecole Normale Supérieure, Paris**

*(post-doc, supervisor: Srdjan Ostojic)*

I am training machine learning tools (Recurrent Neural Networks) on various tasks and I use mathematical analysis to describe their dynamical properties and understand the cognitive processes they implement [7,8,9,11].

10/2016-10/2017 **Laboratory of Theoretical Physics, Ecole Normale Supérieure, Paris**

*(1 year, post-doc, supervisors: Rémi Monasson and Alessandro Treves)*

I have worked on a project entitled "Analogue computations underlying language mechanisms". I have used statistical physics tools and numerical simulations to investigate the properties of neural codes involved in representing continuous manifolds of objects [6,12].

10/2014-09/2016 **Laboratory of Theoretical Physics, Ecole Normale Supérieure, Jean Perrin Laboratory, Université Pierre et Marie Curie, Paris, France**

*(2 years, post-doc, supervisors: Rémi Monasson and Georges Debrégeas)*

I have analyzed large calcium imaging datasets (50,000 neurons recorded simultaneously) recorded in behaving animals (zebra-fish larvae). I have used numerical and dynamical system tools to understand how processes of sensory-motor transformations can be implemented in biological neural networks [3,4].

01/2013-08/2014 **Departments of Statistics and Neurobiology, University of Chicago, USA**

*(1 year 6 months, PhD student, supervisor: Nicolas Brunel)*

I have analyzed large-scale cortical connectivity measurements and compare them with connectivity properties of network models of memory [2,12,5,14].

09/2011-12/2012 **Neurophysics and Physiology Laboratory, Paris Descartes University, Paris, France**

*(1 year 6 months, PhD student, supervisor: Nicolas Brunel)*

I have studied the memory properties of various kinds of neural networks, focusing on their synaptic properties, for instance studying slow and fast learning networks [1,13].

04/2009-08/2010 **OEB Department, Harvard University, USA**

(1 year 4 months, intern, supervisors: Yoram Burak and Bence P. Ölveczky)

I have analyzed single-cell recordings in behaving animals (singing zebra-finch) and modeled these data to understand the biological processes underlying learning of motor sequences [16].

## TEACHING

2010 Harvard University: TA for the course “Computational Neuroscience” (30h).

2011 and 2012 Université Paris Descartes : TA in physics for first year medical students: fluid mechanics, electro-magnetism, diffusion (80h).

2011 and 2012 Ecole Normale Supérieure : TA for the course “Advanced Course in Theoretical Neuroscience” (Cogmaster, ENS/EHESS/P5) (40h).

2016 Paris Descartes University: Course of Computational Neuroscience for L3 undergraduate students majoring in mathematics or computer science (25h).

## SUPERVISION

2019 Supervision of a master student in computer science (6 months), on the project: « new models of working memory »

## PUBLICATIONS

[1] Memory capacity of networks with stochastic binary synapses

**A.M.Dubreuil**, Y.Amit, N.Brunel, *PLoS Computational Biology*, 2014.

[2] Storing structured sparse memories in a large-scale multi-modular cortical network model

**A.M.Dubreuil**, N.Brunel, *Journal of Computational Neuroscience*, 2016.

[3] Rheotaxis of larval zebrafish: behavioral study of a multi-sensory process

R.Olive, S.Wolf, **A.Dubreuil**, V.Bormuth, G.Debrégeas, R.Candelier, *Frontiers in System Neuroscience*, 2016.

[4] A sensori-motor hub driving phototaxis in zebrafish

S.Wolf\*, **A.M.Dubreuil\***, T.Bertoni, U.Lucas Böhm, V.Bormuth, R.Candelier, S.Karpenko, D.G.C. Hildebrand, I.Bianco, R.Monasson, G.Debrégeas, *Nature Communications*, 2017.

\* equal contributions

[5] Short-term memory properties of sensory neural architectures

**A.M.Dubreuil**, *Journal of Computational Neuroscience*, 2019.

[6] Encoding of multiple spaces in grid-cell networks

D.Spalla\*, **A.M.Dubreuil\***, R.Monasson, A. Treves, *Neural Computation*, 2019.

\* equal contributions

[7] Dynamics of random recurrent networks with correlated low-rank structure

F. Schuessler, **A.Dubreuil**, F.Mastrogiuseppe, S.Ostojic, O.Barak, accepted in *Physical Review Research*, 2020.

[8] Disentangling the roles of dimensionality and cell classes in neural computations

**A.M.Dubreuil**, A.Valente, F.Mastrogiuseppe, S.Ostojic, short paper in **NeuriPS** workshop Neuro-AI, 2019.

## PIPELINE

[9] On the role of populations in neural computations

**A.M.Dubreuil**, A.Valente, F.Mastrogiuseppe, S.Ostojic, in preparation.

## CONFERENCE PROCEEDINGS

[10] “Neural mechanisms underlying reduction in behavioral variability during trial-and-error learning”

A.M.Dubreuil, F.Mastrogiuseppe, S.Ostojic, *COSYNE meeting*, 2019.

Travel grant awarded to the 20 best graded submissions (>1000 submissions)

[11] "Reverse-engineering recurrent neural networks via low-rank approximations"  
A.M.Dubreuil, S.Ostojic, *Bernstein Conference*, 2018.

[12] "Encoding of multiple spaces in grid-cell networks"  
A.M.Dubreuil, R.Monasson, A.Treves, *CNS meeting*, 2017.

[13] "Memory capacity of networks with stochastic binary synapses"  
A.M.Dubreuil, Y.Amit, N.Brunel, *CNS meeting*, 2013.

[14] "Storing structured sparse memories in a large-scale multi-modular cortical network model"  
A.M.Dubreuil, N.Brunel, *COSYNE meeting*, 2013.

[15] "Binary connectivity matrices storing complex memories in a multi-modular network"  
A.M.Dubreuil, N.Brunel, *FENS workshop*, 2012 : "Dynamics of memory : what's the evidence".

[16] "Neural mechanisms underlying reduction in behavioral variability during trial-and-error learning"  
A.M.Dubreuil, Y.Burak, B.P.Ólveczky, *COSYNE meeting*, 2010.

### **INVITED TALK IN INTERNATIONAL CONFERENCE**

"Disentangling the role of dimensionality and cell classes in neural computations", October 2019, Statistical Physics and Neural Computation, Guangzhou, China.

### **SELECTED TALK IN INTERNATIONAL CONFERENCE**

"A sensori-motor hub driving phototaxis in zebrafish", September 2017, Neural Coding, Computation and Dynamics, Capbreton, France.

### **SELECTED TALK IN NATIONAL CONFERENCE**

"Disentangling the roles of dimensionality and cell classes in neural computations", December 2019, GDR NeuralNet, Bordeaux.

"Minimal-dimensionality implementation of behavioral tasks in recurrent networks", June 2019, NeuroCompDays, Sorbonne Université, Paris.

### **INVITED SEMINARS**

"Disentangling the role of dimensionality and cell classes in neural computations", November 2019, Group for cortical dynamics, IDIBAPS, Barcelona, Spain.

"A sensori-motor hub driving phototaxis in zebrafish", June 2017, Bernstein Center for Computational Neuroscience, Berlin, Germany.

"A sensori-motor hub driving phototaxis in zebrafish", May 2017, Group for cortical dynamics, IDIBAPS, Barcelona, Spain.

"Modeling networks of head-direction cells with non-linear dendritic interactions", January 2017, IBENS, ENS, Paris, France.

"Shaping effective connectivity via non-linear dendritic interactions allows precise network control", December 2016, MNEMOSYNE, INRIA, Bordeaux, France.

"Memory and cortical connectivity", June 2014, Unité de Neurosciences Information et Complexité, Gif-sur-Yvette, France.

"Neural mechanisms underlying the reduction in behavioral variability during trial-and-error learning", May 2010, Laboratory of Neurophysics and Physiology, Paris Descartes University, Paris, France.

### **REVIEWING ACTIVITIES**

NeurIPS, ICLR, Organization for Computational Neuroscience, Physical Review Letter, Physical review E

### **POPULARIZATION**

I gave a talk "Cerveau et Intelligence Artificielle" at Université Populaire de la Dore, to provide an overview of research conducted in these two fields for a general audience.

### **COMPUTER SCIENCE SKILLS**

Programming: Python, Matlab, Fortran ; Deep-learning: Keras, Pytorch ; Others: Mathematica, Webdesign