# Raphaëlle **Momal**

APPLIED MATHEMATICS · PHD CANDIDATE

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## Current Position

**PhD student in Mathematics applied to Biology and Ecology**     *16 rue Claude Bernard, Paris (75)*

MIA-PARIS (APPLIED MATHEMATICS AND IT), AGROPARIS TECH, INRAE, PARIS-SACLAY UNIVERSITY     *Oct 2017 - Present*

- **Supervisors:** Stéphane Robin (INRA, MIA-Paris), Christophe Ambroise (LaMME, Évry)

- **Aim:** Infer species interaction networks from abundance data, in presence of unobserved major actors.

- **Keywords:** Variational Expectation-Maximization algorithm, Graphical models, Spanning trees dependency structures, Matrix Tree Theorem, Poisson log-Normal distribution

## Education

**Research M.S. in Mathematics applied to Statistics**     *Rue du Thabor, Rennes (35), France*

RENNES 1 UNIVERSITY     *2016 - 2017*

**M.S. Biostatistical Engineer**     *Rue Blaise Pascal, Bruz (35), France*

ENSAI (NATIONAL SCHOOL FOR STATISTICS AND DATA ANALYSIS)     *2014 - 2017*

**CPGE MPSI/MP**     *44 Bd Saint-Michel, Paris (75), France*

LYCÉE SAINT-LOUIS     *2012 - 2014*

## Skills

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|---|---|
| **Programming** | R (expert), Latex (good), C++ (basic), Python (basic) |
| **Desktop tools** | R Markdown, github, Linux |
| **Languages** | French (mother tongue), English (C1, almost native), German (B2, intermediate) |

## Experience

**PELAGIS Observatory - UMS 3462**     *5 Allée de l'Océan, La Rochelle (17)*

SCIENTIFIC STAY     *Jun. 2019*

- Worked together with Matthieu Authier to expend our inference method of species interaction networks to macro-ecology.
- Data analysis of 2016 marine mega-fauna survey from New Caledonia

**INRA - GABI - PSGen**     *Allée de Vilvert, Jouy-en-Josas (78)*

INTERNSHIP - BIOSTATISTICS RESEARCH ENGINEER     *Apr. 2017 - Oct. 2017*

- Worked under the supervision of Dr. Andrea Rau on statistical integration of OMICS data (RNA-seq, ATAC-seq and HiC data), part of the FR-AgENCODE project (functional annotation of livestock genomes).
- Used the mixed-model paradigm to assess the importance of taking both into account the DNA 3D structure and the chromatin accessibility when explaining the genome-wide expression.

**Soladis**     *94 Rue Saint-Lazare, Paris*

INTERNSHIP - STATISTICAL ENGINEER     *Jun. 2016- Sept. 2016*

- Worked in supervised autonomy on several biotech problems
- Used SAS software to implement logistic regression models, ANOVAs, Bayesian estimation MCMC procedures.

# Teaching Experience

### Statistical data analysis with R - IT Sessions
*Paris-Saclay University (LMO)*

L3 Level
*Jan. 2020 - present*

- Introduce R programming to HEC students and Paris-Saclay students in IT and mathematics (3rd year).
- Teach both the programming language, and peculiar statistical functions dedicated to statistical data analysis.

### Mathematical Modelling - Exercises Sessions
*Paris-Saclay University (bat. 336)*

L1 Level
*Oct. 2019 - Jan 2020*

- First year students in biology (BCPST)
- Function analysis (one and several variables), Probabilities computation, random variables (discrete and continuous), Laws approximation.

### MISS (House for Science Initiation and Awareness) - scientific mediation
*Paris-Saclay University (bat. 224)*

School pupils from 8 to 15 years old
*Oct. 2017 - Oct 2019*

- History of numbers: how did they count in Mesopotamia without our current numerary system?
- Mathematics and Botany: to the discovery of fractals in nature.
- Bubbles and foam: how can a foam be solid and liquid both at the same time.

The aim of MISS is to bring the lab into the classroom. Teachers would come with their class at MISS and experiment on a specific subject during an entire day. These scientific workshops are animated by junior scientists (often PhD students), which facilitate exchanges with students.

# Scientific production

*Articles*

### Accounting for missing actors in interaction network inference from abundance data
*arXiv preprint*

R. Momal, S. Robin, C. Ambroise

Preprint
*2020*

- Extends the inference method to account for missing actors.
- A simulation study shows the method's efficiency, and two examples using field data illustrates its usage.

### Tree-based Inference of Species Interaction Networks from Abundance Data
*Methods in Ecology and Evolution*

R. Momal, S. Robin, C. Ambroise

DOI:10.1111/2041-210X.13380
*2020*

- Explains the inference method developed in the PhD project, compares it to existing methods and illustrates its application with examples using field data.
- This article is written towards the community of ecology, by bringing together concepts from the fields of mathematics, statistics and ecology.

### Multi-species annotation of transcriptome and chromatin structure in domesticated animals.
*BMC Biology vol.17(1), Art. n°108*

Sylvain Foissac, Sarah Djebali, Kylie Munyard, Nathalie Vialaneix, Andrea Rau and 31 others

DOI:10.1186/S12915-019-0726-5
*2019*

*IT materials:*

### nestor (https://github.com/Rmomal/EMtree)

R PACKAGE

- Network inference from Species counTs with missing actORs: nestor is an R package implementing the extended inference method accounting for missing actors.

### EMtree (https://github.com/Rmomal/EMtree)

R PACKAGE

- EMtree is an R package implementing the inference method developed in my PhD project.
- EMtree was developed as a tool for experts in biology and ecology who wishes to infer a direct dependency network from abundance data they collected.
- The method is appreciated as it efficiently handles environmental covariates, and experimental offsets.

### Fancy plotting with ggraph, gganimate (https://stateofther.github.io/post/fancy-plotting/GG.html)

STATEOFTHER WORKSHOP

- Introduction to ggplot framework and gganimate, examples and exercises
- Networks with ggraph and tidygraph, examples and exercises
- Edge selection on a simulated ecological dataset

# Scientific groups

### StateOfTheR (https://stateofther.github.io/)

SELF-STUDY GROUP

- A group of researchers and engineers who meet to deepen their know-how, improve the dissemination of their statistical methods and exchange views on the latest innovations in the field of statistics.
- Participate to monthly workshops and annual bootcamps
- Co-designed and led a workshop with *Marie Perrot-Dockes* on how to use ggplot and R's newest packages to draw fancy graphs, and networks in particular

### EcoStat (https://sites.google.com/site/gdrecostat/)

RESEARCH GROUP

- Development and application of statistical methods and tools for ecology and evolutionary biology
- Benefited from a grant from the group for a stay in an ecology laboratory (PELAGIS Observatory, La Rochelle, France).

### EcoNet (https://cmatias.perso.math.cnrs.fr/ANR_EcoNet.html)

ANR RESEARCH PROJECT

- Advanced statistical modelling of ecological networks

# Conferences

*With talk:*

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| Mar. 2020 | **EcoStat GdR,** Conference of the EcoStat Research Group | *Rennes, France* |
| Sep. 2019 | **WiMLDS,** Women in Machine Learning and Data Science | *Paris, France* |
| Jan. 2019 | **SMPGD,** Statistical Methods for Post Genomic Data | *Barcelona, Spain* |
| Dec. 2018 | **NETBIO,** Networks inference in Biology | *Montpelier, France* |
| Jul. 2018 | **JOBIM,** Open Days of Biology, IT and Mathematics | *Marseilles, France* |

*Attended:*

| | | |
|---|---|---|
| Oct. 2019 | **NETBIO,** Networks inference in Biology | *Saclay, France* |
| Sep. 2019 | **networks2019 ,** 4th Symposium on Ecological Networks | *Paris, France* |
| Jul. 2019 | **MMEE ,** Mathematical Models in Ecology and Evolution conference | *Lyon, France* |
| May 2019 | **JDS,** Statistical Days | *Nancy, France* |
| Feb. 2019 | **SatRday,** International conference on R | *Paris, France* |
| Oct. 2018 | **EcoStat GdR,** Conference of the EcoStat Research Group | *Grenoble, France* |
| May 2018 | **JDS,** Statistical Days | *Saclay, France* |

## Research Schools

*With talk:*

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|---|---|---|
| Aug. 2019 | **FINIST'R 19,** R and GitHub summer bootcamp organised by StateOfTheR. | *Roscoff, France* |
| Feb. 2019 | **COSTNET,** European early career training - Networks. Course by **Tom A.B. Snijders** (University of Groningen, University of Oxford) and **Tiago de Paula Peixoto** (University of Bath). | *Munich, Germany* |
| Aug. 2018 | **FINIST'R 18,** R and GitHub summer bootcamp organised by StateOfTheR. | *Beg Meil, France* |
| May 2018 | **Chaire MMB ,** Spring Research School - Mathematical Modeling and Biodiversity. Course by **S. Robin** and **J. Josse**. | *Aussois, France* |
| Mar. 2018 | **Rochebrune Seminar,** Winter Research School - Statistical Seminar. Course by **Julyan Arbel**. | *Rochebrune, France* |

*Attended:*

| | | |
|---|---|---|
| Sep. 2019 | **StatMathAppli'19,** Summer Research School. Course by **P. Bühlmann** and **M. Lerasles** | *Fréjus, France* |