Research activities

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I am a computer scientist, my research interests include machine learning, verification, game theory, and logic, and particularly the interactions between these fields.

This report outlines a summary of my research since January 2017 when I started as a Turing Research Fellow. I have taken a leave from the Turing on January 2018 to take up a faculty (full-time researcher) position at CNRS (Centre National de la Recherche Scientifique), affiliated to LaBRI, Bordeaux. The structure of the document follows the chronological order: the first year in London, the next two and half years in Bordeaux, and perspectives.

A list of all my publications since January 2017 can be found at the end of this document.

January 2017 – January 2018: London

The Logics research interest group

David Pym, David Aspinall, and myself served as convenors for the "**Logical foundations for data science**" research interest group. The activities were communicated via a mailing list gathering over a hundred researchers across the UK (still active today for advertising scientific events). We organised a monthly seminar series for the year 2017, and in January 2018 held a Turing workshop "**Logic & Learning**" co-organised with David Pym and Andrew Blake, with *over a hundred* attendants.

Research project

I was the lead investigator of the Turing project "**Making things simple before learning them**", which aimed at a theoretical understanding of some machine learning tasks, and in particular reinforcement learning. See

`https://www.turing.ac.uk/research/research-projects/making-things-simple-learning-them`

Led in particular to the publications [FKP17; CFKP19; CMFGP20].

Involvement at the Turing and in Warwick

- Feb 2017: convenor and panel member for the PhD interviews at the Turing
- Nov 2017: speaker at the Warwick-Turing workshop in Warwick
- Feb 2018: convenor for the PhD interviews at the Turing

January 2018 – now: Bordeaux

I am a member of the Formal Methods team and the head of the DART group (Decisions, Learning, and Robotics) in LaBRI, Bordeaux. I organise the "Theory of Machine Learning" biweekly seminar and the weekly Formal Methods team seminar.

I am the principal investigator of the DeepSynth CNRS Momentum grant, which is a three-year research grant (180k euros plus a two-year postdoctorate position). The objective of the DeepSynth project is to use learning techniques for program synthesis.

During this period of time I maintained close connections with the Turing. Below I outline the scientific Turing related projects.

Scientific events

- July 2018: Turing sponsored summer school "**Logic & Learning**" in Oxford co-organised with Alexandra Silva, David Pym and Prakash Panangaden. The school was part of the FoPSS series, and in the official programme of FLOC (Federated Logic Conference) in Oxford.
- July 2018: Turing sponsored workshop "**Summit on Machine Learning Meet Formal Methods**" in Oxford co-organised with Marta Kwiatkowska and Stephen Roberts.

Collaborations

Three successful visitor (internal and external) grants.

- March 2018 to June 2018 (part-time): Laurent Doyen was a **Rutherford Visiting Fellow** visiting the Turing and University of Warwick.
- May to July 2018: Prakash Panangaden was a **Leverhulme Invited Professor** visiting the Turing and University College London. Let to the publications of these papers [FKP17; CFKP19].
- June to Sept 2018: two Turing interns (Judith Clymo and Haik Manukian) on the topic "An interdisciplinary approach to Programming by Example", co-supervised with Adria Gascon and Brooks Paige. Let to the publication of this paper [CMFGP20].
- August to December 2018: Alexander Clark was a **Turing Researcher** visiting the Turing. Let to the publication of this paper [CF20].

Perspectives

The goal of my research is to combine machine learning and formal methods for synthesis, meaning the automatic construction of controllers or programs. As a Turing Research Fellow I have been given many opportunities to realise and enrich this research endeavour, and I am hoping to continue in this direction. I am currently preparing for an ERC application on "Synthesis in the Learning Era".

Publications since 2017

[BFLM20] Corentin Barloy, Nathanaël Fijalkow, Nathan Lhote, and Filip Mazowiecki. "A Robust Class of Linear Recurrence Sequences". In: *CSL*. 2020, 9:1–9:16. DOI: 10.4230/LIPIcs.CSL.2020.9. URL: https://doi.org/10.4230/LIPIcs.CSL.2020.9.

[CF20] Alexander Clark and Nathanaël Fijalkow. "Consistent unsupervised estimators for anchored PCFGs". In: *Transactions of the Association for Computational Linguistics* X (2020), pp. XX–XX.

[CFKP19] Florence Clerc, Nathanaël Fijalkow, Bartek Klin, and Prakash Panangaden. "Expressiveness of probabilistic modal logics: A gradual approach". In: *Information and Computation* 267 (2019), pp. 145–163. DOI: 10.1016/j.ic.2019.04.002. URL: https://doi.org/10.1016/j.ic.2019.04.002.

[CMFGP20] Judith Clymo, Haik Manukian, Nathanaël Fijalkow, Adrià Gascón, and Brooks Paige. "Data Generation for Neural Programming by Example". In: *AI&STATS*. 2020, pp. XX–XX.

[CF19] Thomas Colcombet and Nathanaël Fijalkow. "Universal Graphs and Good for Games Automata: New Tools for Infinite Duration Games". In: *FoSSaCS*. 2019, pp. 1–26. DOI: 10.1007/978-3-030-17127-8_1. URL: https://doi.org/10.1007/978-3-030-17127-8_1.

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[FGKK17] Nathanaël Fijalkow, Hugo Gimbert, Edon Kelmendi, and Denis Kuperberg. "Stamina: Stabilisation Monoids in Automata Theory". In: *CIAA*. 2017, pp. 101–112. DOI: 10.1007/978-3-319-60134-2_9. URL: https://doi.org/10.1007/978-3-319-60134-2_9.

[FKS20] Nathanaël Fijalkow, Stefan Kiefer, and Mahsa Shirmohammadi. "Trace Refinement in Labelled Markov Decision Processes". In: (2020), pp. XX–XX.

[FKP17] Nathanaël Fijalkow, Bartek Klin, and Prakash Panangaden. "Expressiveness of Probabilistic Modal Logics, Revisited". In: *ICALP*. 2017, 105:1–105:12. DOI: 10.4230/LIPIcs.ICALP.2017.105. URL: https://doi.org/10.4230/LIPIcs.ICALP.2017.105.

[FLOS20] Nathanaël Fijalkow, Guillaume Lagarde, Pierre Ohlmann, and Olivier Serre. "Lower Bounds for Arithmetic Circuits via the Hankel Matrix". In: *STACS*. 2020, 24:1–24:17. DOI: 10.4230/LIPIcs.STACS.2020.24. URL: https://doi.org/10.4230/LIPIcs.STACS.2020.24.

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