THE NETWORKS-COFUND PROJECT

Information Package for Postdoc Applicants

The NETWORKS project is a collaboration of world-leading researchers from four institutions in The Netherlands – TU Eindhoven, University of Amsterdam, Leiden University and the Centrum Wiskunde & Informatica (CWI) – focusing on the stochastics and algorithmics behind network problems. It offers a highly stimulating research environment and an extensive training program for PhD students and postdoctoral fellows from all over the world. NETWORKS was awarded a COFUND grant from the Marie Skłodowska-Curie Actions (MSCA), funded by the European Commission. The grant allows NETWORKS to expand its activities by opening positions for additional international postdoctoral fellows.

The NETWORKS members

Within this programme we have a vacancy for a **24-month postdoctoral fellow in discrete mathematics** at the Korteweg-de Vries Institute for Mathematics of the **University of Amsterdam**.

In this document you can find more information about the research themes studied in the project, the training programme, and the application procedure, including eligibility criteria.

Contents

Research themes within NETWORKS

Research in NETWORKS focuses on *stochastics* (including queueing theory, random graphs, stochastics processes, stochastic optimization) and *algorithmics* (including computational geometry, graph theory and algorithms, combinatorial optimization, quantum algorithms, algorithmic game theory) for *network* problems. In Appendix A you can find an overview of the research themes within the NETWORKS project.

For more information on the research themes in NETWORKS, see Appendix A.

Research in the specific position of this advertisement focuses on **extremal/probabilistic combinatorics and/or structural graph theory**. The first supervisor will be **Ross Kang**.
The selection process takes an eye for bridging to other members of the **DMQI group**, such as Jo Ellis-Monaghan, Krystal Guo and Guus Regts, and thus towards algebraic/topological methods and randomized algorithms, as well as to other members/themes of the **NETWORKS consortium**.

Research opportunities and Training Program

The core of your appointment will be to perform research, in collaboration with and coached by your supervisor(s). NETWORKS offers an excellent environment for research. In addition to your main supervisor, you will be assigned a second supervisor who brings in additional expertise. Supervisors work very closely with their postdoctoral fellows and PhD students, to maximize the quality of the research. You will also have a generous travel budget, allowing you to visit international conferences, workshops, summer schools and research visits to universities outside The Netherlands.

NETWORKS offers an extensive and inspiring training program. The program includes the components listed below. In addition, there are several other NETWORKS events that you will participate in.

Training Weeks. NETWORKS organizes two Training Weeks per year. Each Training Week comprises two *mini-courses*, one on a topic from stochastics and one on a topic from algorithmics. Next to the mini courses there are *research presentations* by NETWORKS researchers (PIs or other staff members, postdocs and PhD students) about their current work, and *working sessions* where participants can collaborate on research problems. The Training Weeks are held at off-campus locations, to maximize social interaction and community building among the NETWORKS researchers.

Community building event

Industrial Internships. Each postdoc will be involved in an internship of 2-3 months in a non-academic environment, either as co-supervisor of a PhD student doing an extensive internship or working on your own project.

Professional skills courses. There are a variety of courses on professional skills and personal development available to NETWORKS members. These include courses on technical writing and giving presentations, developing teaching skills, personal effectiveness, and more. Together with

your supervisor, you decide on a personal course program. A course on Analytic Story Telling is mandatory.

The research and training program of NETWORKS offers you excellent opportunities for a future career, be it in academia, government, or industry. NETWORKS graduates found jobs at top academic institutions, both in and outside Europe (including MIT, Georgia Tech, Warwick University, and Max-Planck-Institut für Informatik), at major multinationals in the high-tech and financial industry (including Microsoft, Google, PriceWaterhouseCoopers and ABN-AMRO), and at medium-size companies and start-ups.

Eligibility and selection criteria

In order to be eligible, a postdoctoral fellow in the NETWORKS COFUND program, you should be **in possession of a PhD degree or obtain one within three months at the starting date of your appointment**. We focus on training researchers in the early stages after their PhD, so you have ***at most*** three years full-time post-PhD-degree research experience at the date of recruitment.

Moreover, you meet the mobility requirement of the MSCA, which encourages transnational, intersectoral and interdisciplinary mobility. The mobility requirement is: You **may not** have resided or carried out your main activity (work, studies, etc.) in the Netherlands **for more than twelve months in the three years** immediately before the call deadline.

We are looking for highly motivated and independent researchers in **discrete mathematics**. We in particular seek talented researchers with expertise in **extremal/probabilistic combinatorics and/or structural graph theory**.

We encourage candidates who not only fortify and complement the research capabilities of the **DMQI group** at the Korteweg-de Vries Institute but also integrate naturally within the NETWORKS project. As such, talented researchers with (additional) expertise in algebraic/topological methods for combinatorics, or (randomized) algorithms will also be strongly considered.

The prospective main supervisor, **Ross Kang**, has been active in efforts towards improving openness and inclusion in the (mathematical) sciences. We encourage applications from all qualified, interested applicants, and we aspire to broaden the perspectives of the DMQI group and the NETWORKS team.

The evaluation criteria are:

- Quality of your research proposal (50%):
  a) the originality and ambition of the project, the extent to which it is feasible, appropriate consideration of inter- and multi-disciplinary aspects;
  b) the approach and proposed research methodology, feasibility of proposed time-scale;
  c) societal use, exploitation and dissemination.
- Your experience as a researcher and your skills (40%):
  a) track record in performing research, knowledge and experience, evidence of creative thinking, independence and leadership potential;
  b) verbal and oral communication skills (in English), potential for rapidly gaining new skills.
- Commitment to the project, open mindedness, motivation for NETCO-PD (10%).

Application procedure and eligibility criteria

The deadline for application is **20 October 2023**.

You should fill in the online application form and **provide the following documents combined in one pdf**, in English:

- A proposal (about 3-5 pages) with your research idea and main aim(s), briefly describing approach, methodology, challenges, originality, time table, required training, ethical issues, and potential societal use.
- A motivation letter that must, among other things, mention the NETWORKS research theme(s) you are interested in and the motivation for working within NETWORKS and the DMQI group of the Korteweg-de Vries Institute at the University of Amsterdam.
- Your CV.
- A copy of your PhD degree and (a link to) your PhD thesis, or the contact details of your PhD advisor(s) who can directly vouch for your nearing completion of the PhD.
- The names and email addresses of up to three references, who will be contacted by us for recommendation letters.

Diversity and equal-opportunities policy

NETWORKS values an inclusive and diverse working environment, and we encourage all candidates to apply, irrespective of their gender, religion, sexual orientation or disabilities. When evaluating the candidates, we will take parental leave and other personal circumstances into account, and we will strive for a candidate who complements the breadth and diversity of our group.

Employment conditions and support

As a postdoctoral fellow in the NETWORKS-COFUND program, you will be appointed at the University of Amsterdam, following the Collective Labour Agreement (CAO) of Dutch Universities. The salary will be € 3226 to € 5090 gross per month, based on a fulltime contract (38 hours a week).

The appointment will be for **24 months**. The starting date is flexible, within limits. The preferred start is **1 January 2024 or earlier**. The latest possible starting date is 1 April 2024.

The HR department of the institution where you will be employed will assist you in obtaining a visa and work permit if needed. They can also help you with looking for housing.

Appeal procedure

If you feel your application has been rejected on improper grounds, then you can appeal the decision. You should do so within 14 days of the decision by sending an email to the Managing Director of the Mathematical Institute at Leiden University, dr. P.M. Overgaauw (mi-instituutsmanager@math.leidenuniv.nl).

Contact

If you have any questions, feel free to get in contact with Ross Kang (r.kang@uva.nl).

Appendix A: The NETWORKS project and research themes

Networks for communication, transportation, finance and energy form the backbone of modern society. Reliable and efficient network infrastructures are of enormous economic and social value, and their importance will only increase in the coming years. Researchers in the NETWORKS project perform research in *stochastics*, to model and understand large-scale networks (and to predict network growth and network processes) and *algorithmics*, to control and optimize networks and network processes in the best possible way. The research is of a fundamental nature: the goal is to develop new theory in the areas of stochastics and algorithms, thus proving a deeper understanding of mathematical and algorithmic techniques needed to model, control and optimize (processes on) networks.

The NETWORKS research program is organized around eight themes. These themes should not be interpreted as disjoint research lines, but rather as "views'' that stress different aspects. Some themes focus on algorithmic techniques (Approximate and exact network methods, Quantum network algorithms), others on different structures of networks (Spatial networks), on dynamic networks and network processes (Dynamics on networks, Dynamics of networks), and on specific applications (Transportation networks, Communication networks and Energy networks).

Theme 1: Approximate and exact network methods. Algorithmic problems concerning the design, optimization, and control of networks are often NP-hard, meaning that no efficient algorithms exist that solve these problems optimally on all possible instances. We study two approaches to deal with this. One is to develop approximation algorithms, which are guaranteed to compute near-optimal solutions. Another is to exploit that not all input instances are equally hard: some enjoy structural properties that can be exploited to efficiently compute an optimal solution.

Theme 2: Spatial networks. Many real-world networks are spatial: nodes have a location in space and edges are defined by physical connections or geographic proximity between the nodes. Typically, connections between nearby nodes are more abundant than connections between distant nodes, yet long-range connections play a crucial role in the behaviour that these networks exhibit. In addition, a high variability in the degrees of the nodes is observed. We study how and in which situations it is possible to exploit the geometry of the network, to obtain better solutions to network problems.

Theme 3: Quantum network algorithms. Quantum computers are based on the laws of quantum mechanics. They hold great promise as a future generation of hardware, since computing with qubits—a qubit is the quantum equivalent of a classical bit—allows for massive parallel computing. NETWORKS focuses on quantum software for networks problems. A key question is which computational problems can be solved significantly faster on quantum computers, and which are still very hard. NETWORKS collaborates with QuSoft Amsterdam, the first research centre in the world exclusively dedicated to quantum software.

Theme 4: Dynamics of networks. Networks evolve over time, in a way that is typically closely related to their functionality. The theory of random graphs is an essential mathematical tool to model real-life network structures as stochastic objects that grow in time according to certain local growth rules. By adapting these rules, different types of dynamic network behaviour can be captured and analysed. Within NETWORKS we develop and analyse random-graph models and we investigate which models are best for which applications.

Theme 5: Dynamics on networks. Network functionality can often be described in terms of stochastic processes taking place on networks. Mathematical theory that applies to real-world networks is scarce, however, since existing theory focuses on random processes in very regular networks such as grids, while real-world networks are usually highly irregular. Within NETWORKS we investigate how the behaviour of stochastic network processes is affected by the irregular structure of the network, in particular, the presence of “hubs”.

Theme 6: Transportation networks. The efficient usage of road, railway and other transportation networks poses many mathematical challenges. The challenges arise in all stages, from the design of the network, to the regulation of network traffic, and the maintenance or expansion of the network. Research within NETWORKS deals both with structure-related issues (planning and dimensioning of transportation and traffic networks) and with the operations on existing networks (routing, scheduling and other traffic management mechanisms relating to shorter time scales).

Theme 7: Communication networks. Communication networks need to be designed to consistently achieve high levels of performance and reliability, and yet be cost-effective to operate. This is highly challenging because of the variability in network traffic as well as the enormous complexity of communication networks such as the internet. We study e.g. how processes on networks (such as the spreading of viruses, fake news, etcetera) evolve and can be controlled, and how to construct and control communication networks to maximize efficiency.

Theme 8: Energy networks. The shift towards renewable energy sources such as wind and solar energy is causing a significant variability in supply to electricity networks. As a result supply and demand may no longer match at any given time, leading to serious reliability issues and loss of efficiency. Our research aims at getter a better grip on this by developing and analyzing novel mathematical models for energy networks.