THE NETWORKS-COFUND PROJECT

Information Package for PhD Applicants

The NETWORKS PhD students

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 from all over the world. Recently 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 an additional 14 international PhD students.

The 14 PhD students are recruited in three Calls: the first two calls have been organized in the past year. In this third call there are 6 positions available. In this document you can find more information about the research themes studied in the project, the potential supervisors and their research projects, and the application procedure including eligibility criteria.

Contents

Overview of selection process and important dates

In a nutshell, the selection process is as follows. After the application deadline (May 31), the Selection Committee will make a longlist of candidates who will be invited for a first interview. Based on these first interviews, the Selection Committee will make a shortlist of candidates who will be invited for a second interview. After these second interviews, a final decision will be made about whether you will receive an offer for one of the available PhD positions. The dates of the various steps in the process are listed below. The listed dates – all dates are in 2020 – refer to the first call. There will be a second call opening November 1, 2020.

Possible research projects for PhD students

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) for network problems. In Appendix A you can find a list of supervisors and possible projects. When you are selected to join the NETWORKS project, you will further develop the topic of your research project together with your supervisor in the first few months of your appointment.

For more information on potential supervisors and their research interests, see Appendix A.

Research opportunities and Training Program

The core of your PhD studies will be to perform research, in collaboration with and coached by your supervisor(s). NETWORKS offers an excellent environment for this. In addition to the main supervisor, you will be assigned a second supervisor who brings in additional expertise. Supervisors work very closely with their PhD students, to maximize the quality of the research. You will also have a generous travel budget, allowing you to visit international conferences, workshops and summer schools. Moreover, each PhD student has the opportunity to make one or two research visits to universities outside The Netherlands. The visits will last two weeks or more, and the host university is chosen depending on your own specific research topic.

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 can participate in.

Training Weeks. NETWORKS organizes two Training Weeks per year. The morning sessions in each Training Week are devoted to two *mini-courses*, one on a topic from stochastics and the other on a topic from algorithmics. The afternoon sessions feature *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 PhD student will do an internship of 2-3 months in a non-academic environment, typically in the second or third year of her/his PhD.

Professional skills courses. There is a variety of courses on professional skills and personal development available to NETWORKS PhD students. 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.

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.

PhD graduation ceremony

Being a PhD student in the Netherlands

In the Netherlands, every PhD student gets paid a salary; no additional grants are needed. Moreover, even though NETWORKS offers an extensive training program that allows you to expand your knowledge and skills (see above), there are no exams or course requirements. Hence, PhD students are more like employees than like students. Your work as a PhD student may include being a teaching assistant (TA) in BSc or MSc courses offered at your institution. This amounts to up to 15% of the time; the remaining time is spent on research and research-related activities such as the training program. As an international PhD student you need not speak Dutch: it is easy to get by with English, not only at the university but also in everyday life.

Selection criteria

We are looking for enthusiastic and motivated applicants with a background in mathematics (in particular stochastics) and an affinity for computer science, or with a background in computer science (in particular algorithms) with affinity for mathematics. You should have an MSc degree or be close to obtaining it. The evaluation criteria are:

- Research potential (grades, creativity and independence): 40%
- Verbal and oral communication skills (in English): 20%
- Educational background and other experience: 20%
- Commitment and enthusiasm: 20%

Application procedure and eligibility criteria

In order to be eligible, make sure you send **your complete application before the deadline** of the call. At the starting date of your employment as a PhD student in the NETWORKS COFUND program, you should be in possession of an MSc degree. 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 starting date of your employment.

Applications should be done through the online system available at the NETWORKS website. You should fill in the online application form and **provide the following documents combined in one pdf**, in English:

- A motivation letter that, among other things, mentions the project(s) you are interested in (see Appendix A);
- A CV including (if applicable) a list of publications and experience with teaching;
- A copy of your MSc diploma or a transcript specifying the number of credits they thus far obtained in their MSc studies and a list of grades for your MSc courses.

In the online application system you can supply 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 diverse composition of the appointed PhD students.

Employment conditions and support

As a PhD student in the NETWORKS-COFUND program, you will be appointed at the institution of your main supervisor (TU Eindhoven, University of Amsterdam, Leiden University, or CWI). Appointments at TU/e, UvA and LU will follow the Collective Employment Agreement (CAO) of Dutch Universities, and the appointments at CWI will follow the CAO for Research Centres (which is essentially the same). Gross salary ranges from € 2.395 per month in the first year increasing up to € 3.061 in the fourth year. All institutions offer a broad package of fringe benefits.

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 when looking for housing.

Appeal procedure

If you feel your application has been rejected on improper grounds, 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 Department of Mathematics and Computer Science at TU Eindhoven, dr. R.C. van der Drift (R.C.v.d.Drift@tue.nl).

Contact

If you have any questions, please contact info@thenetworkcenter.nl.

Appendix A: List of NETWORKS supervisors and possible projects

Sem Borst (TU Eindhoven)

The research activities of Sem Borst focus on evaluating and optimizing the performance and reliability of large-scale systems that operate under randomness and uncertainty. Typical examples of such systems are communication networks like the Internet, data centers, energy systems, supply chains, transportation networks and hospital operations. While the research topics are strongly inspired by applications, the approach is foundational in nature and driven by mathematical rigor. Key methodological tools in the analysis are stochastic processes, random walks, queueing theory and asymptotic scaling methods. The optimization involves distributed control, resource allocation and scheduling algorithms, with data-driven optimization and stochastic learning techniques playing an increasingly prominent role as well.

- *Possible project: Optimal Routing of Autonomous Vehicles.* This project focuses on optimal traffic flow of self-driving vehicles. This emerging technology creates unique opportunities for managing traffic intersections in a fair and efficient manner, reducing traffic congestion. Utilizing real-time information on the location of each vehicle and being able to communicate with each of them, we can consider new routing policies to steer vehicles through a road traffic network. Specifically, under certain ideal circumstances, slot reservation schemes or platoon forming algorithms can drastically increase the capacity of traffic intersections compared to the current situation. Still, this technology also raises significant mathematical challenges, and little is known about how these algorithms will perform in a network setting and how their performance is in terms of fairness and environment friendliness. These challenges arise in particular from the stochastic nature of traffic flows and the quite complex interactions between autonomous and human operated vehicles.

  This project would be supervised with **Marko Boon**, Marko's main research topics are stochastic queueing models for urban road traffic. He develops efficient algorithms in order to optimally adjust traffic lights to reduce the environmental impact of unnecessarily stopped cars and improve the efficiency of traffic flows and experience for drivers, cyclists and pedestrians. Marko has also been examining whether it is better to have 'smart' in-car navigation devices and 'stupid' infrastructure, or the other way around. Currently, he is especially interested in exploiting the potential of vehicle-to-vehicle communication in order to develop platoon forming algorithms for self-driving vehicles.

Jop Briët (Centrum Wiskunde Informatica)

Jop Briët does interdisciplinary research that combines areas including quantum information theory, additive combinatorics and Fourier analysis and Banach / operator spaces. Examples of how these areas meet include using classical operator space results to characterize quantum algorithms in terms of multivariate polynomials and applying additive combinatorics techniques in the study of quantum entanglement. His current interests include developing non-commutative branches additive combinatorics and of Fourier analysis over the boolean hypercube.

- *Possible project: Testing quantum measurements*
  Quantum entanglement is phenomenon where separate quantum systems form mysterious connections that can be observed when these systems are measured. The presence and even the strength of entanglement can be gauged using particular sequences of local measurements. This project is about developing tests to determine if the right kind of measurements were performed by looking only at the observed measurement outcomes. This will involve proving non-commutative analogs of the Gowers Inverse Theorem from additive combinatorics. As such, this project brings together ideas from quantum information theory, discrete mathematics and representation theory.

- *Possible project: Quantum query complexity*
  A proxy for time-complexity of an algorithm is the number of bits of the input it reads in the worst-case, the so-called query complexity. Quantum algorithms can query input strings in superposition which can sometimes lead to much faster algorithms such as Shor's algorithm for integer factorization. Understanding quantum query complexity is one of the major challenges of quantum computing. This project is about exploiting a recently-discovered characterization of quantum query complexity in terms of polynomials. Fourier analysis of boolean functions and the theory of semidefinite programming (a generalization of linear programming) have given powerful tools to study crude bounds on quantum query complexity in terms of polynomials. In this project, these tools will be sharpened using analytic and operator-space theoretic techniques.

Rajat Hazra (Leiden University)
Rajat Hazra's research focuses on spectral properties of random matrices with dependence and inhomogeneity. Random matrices are important in the study of high dimensional problems in statistics, compressed sensing, random graphs etc. Due to the complex structure of modern networks, inhomogeneity and dependence becomes an inherent part of them. The study of a random matrix requires tools from graph theory, combinatorics, non-commutative independence like free independence. His current interest lies in the spectrum of adjacency and Laplacian matrix of inhomogeneous random graphs. Apart from random matrices and random graphs, he is interested in random interface models, sandpile models and long range percolation.

- *Possible project: Large deviation for random graphs*
  Large deviation theory studies rare events and aims to derive sharp estimates for the probabilities of such events. In the context of random matrices, many large deviation questions are wide open. One of the challenges is to identify the large deviation principle for the empirical measure of the eigenvalues. It is known that, for Wigner matrices with Gaussian entries, the empirical measures of eigenvalues satisfy a large deviation principle with a rate function that is given in terms of free entropy. Free entropy is the non-commutative analogue of classical entropy from information theory, and is minimal when the empirical measure is the Wigner semicircle law. It is also known that the Gaussian condition of the entries can be relaxed to exponentially decaying tails. The present project aims to study the spectrum of random graphs like Erdos-Renyi, Chung-Lu, configuration model, and other inhomogeneous random graphs. In particular, it plans to look at the empirical measure of the eigenvalues of the adjacency matrix of such graphs and derive the rate function explicitly. In many cases the limiting empirical measures need not be the Wigner semicircle law, and hence it is expected that a new rate

function arises. It is expected that non-commutative probability will be a useful tool in deriving relevant properties of the rate function. The large deviations of the largest eigenvalue will be another aspect that the project may explore.

The project will be co-supervised by Frank den Hollander and Luca Avena. The research of Frank den Hollander is on probability theory, with a focus on interfaces with statistical physics, population genetics and complex networks. This includes the study of phase transitions and other critical phenomena in random graphs, random matrices, and disordered media. Luca Avena's research activity is in probability theory with a focus on problems coming from statistical physics and network science, related to the theory of so-called random walks and disordered media.

Remco van der Hofstad (TU Eindhoven)

The research of Remco van der Hofstad focuses on the structure and function of random graph models for complex networks, as well as mathematical statistical physics particularly in high dimensions, and the relations between these topics. The research is fundamental in nature, but is inspired by, and reaches out to, application domains. Examples are the study of the critical nature of percolation and the behavior of random walks on static and dynamic random graphs, as well as more realistic models for the spread of diseases on random graph models with and without geometry. A particular challenge lies in the development of dynamic random graph models whose dynamics is spurred by the dynamics on the network, a topic that is highly relevant for models of the brain and of disease evolution.

- *Possible project: Statistical mechanics of and on random graphs*
  There are intimate ties between algorithmic problems, statistical mechanical models and random graphs. Here, we plan to explore these connections. What can be said about the solution space of the algorithmic assignments, and how do these correspond to phase transitions in the system? What are the right observables to describe such phase transitions, and how do such observables scale in the near-critical regimes? Examples are k-SAT assignment problems, as well as Ising and Potts models.

Michel Mandjes (University of Amsterdam)

Michel Mandjes performs research in the field of applied probability and stochastic operations research. A main role is played by applications of stochastic network theory in the design and control of various types of service systems. One of his current topics of interest lies in developing "inversion techniques" which infer the characteristics of the stochastic processes that feed into a network, solely based on performance measurements from that network. In addition, he has recently focused on algorithms for traffic management in large scale transport systems, including statistically sound procedures to estimate the required input parameters.

- *Possible project: Stochastic Decision Making for Spatial Problems*
  This project covers decision problems in a spatial, stochastic setting. In this context one could think of e.g. delivery services, shared ride services, or various health-care related services. Typical problems could relate to assigning jobs to servers in a spatial setting, route selection and route adaptation (based on real-time information). It is envisaged that the project will combine, and extend, state-of-the-art techniques from stochastic modelling, optimization and machine

learning. The project will likely consist of fundamentally-oriented subprojects as well as subprojects that involve more practical aspects, with explicit room for interaction with industry. The candidate preferably has a background in operations research or applied mathematics.

This project will be co-supervised with René Bekker (Free University Amsterdam). René's research topics are in stochastic modeling and operations research, with an emphasis on the application in health care logistics. In the area of stochastic modeling, one of his current interests is in modeling and analyzing the complex interaction between service behavior and waiting time; this stream of research more foundational in nature. In the context of health care, he studies capacity problems for home care, whereas he is also involved in occupancy predictions of Intensive Care beds due to COVID-19.

- *Possible project: Inverse based input estimation in stochastic networks*
  The goal of this project is to develop and analyze statistical inference methods for networks driven by stochastic processes. A complication that one typically faces is that the stochastic process feeding the network is not observed directly, and therefore indirect estimation techniques are needed. In a quintessential example, from snapshots of the network population one wishes to estimate the network's input characteristics. Over the past years, the envisaged supervisors have built up a considerable track record around this theme. While for specific models results have been established, this area still offers a broad array of challenging open questions. The project lies at the intersection of applied probability and mathematical statistics. Potential application areas include service systems and communication networks.

  This project will be co-supervised with Liron Ravner (Haifa University). The research of Liron involves mathematical modelling and analysis of stochastic systems. In particular, statistical inference and decision making in the context of queues and service systems. This research relies on combining methodology from the fields of applied probability, game theory and statistics.

Jacques Resing **(TU Eindhoven).** The research of Jacques Resing is in general in the area of applied probability and stochastic operations research. The main focus of his research is on the study of different types of queueing problems, with applications in communication and production systems. His current research project deals with the performance analysis of automated warehousing systems. The project proposed below would be co-supervised with Ivo Adan, holding the Manufacturing Networks chair at the Industrial Engineering department at Eindhoven University of Technology.

- *Possible project: Performance analysis of automated warehousing*
  Order picking is the process of finding and extracting products from a storage location in a distribution center to fulfill customer orders. Picking has been recognized as one of the most challenging activities in terms of time, labor, and cost for most warehouses. E-Commerce companies are automating their warehouses at an increased pace to achieve high speed and flexibility in their picking operations. Recent advances in robotics offer a rich variety of warehouse automation technologies that may help realize these objectives. Consequently, warehouse managers are confronted with complex decisions on identifying and tailoring the right mix of warehouse automation technologies. In this project we aim to develop and apply stochastic modeling, simulation, optimization and control techniques to assess the performance of different types of warehouse automation concepts, including (but not limited to) (i) milkrun picking systems, where pickers travel on automated trolleys along the aisles to dynamically pick

orders, (ii) collaborative picking which is a semi-automated picking concept where automated guided vehicles assist pickers, and (iii) mobile fulfillment systems where autonomous shuttles do the picking.

Frits Spieksma (TU Eindhoven).
Frits Spieksma is interested in combinatorial optimization problems—for example routing, clustering, and scheduling problems (in particular sport scheduling)—and he studies both their theoretical properties as well as in their applications. Understanding the precise solvability of such problems is the driving theme of his research.

- *Possible project: Fairness in Combinatorial Optimization*
  Recently the issue of fairness in decision-making algorithms is getting more and more attention. The goal of this project is to study fairness in combinatorial-optimization problems. As an illustration, consider the following problem. Given a directed graph, we want to find a cycle packing (that is, a collection of disjoint cycles) covering as many nodes as possible. A node can stand for an individual, and when a node is selected to be in the cycle packing, the corresponding individual receives something valuable. In addition, each node is labelled with a property, say {red, blue}. Fairness of a solution dictates that this feature should be taken into account when producing a solution. For instance, if all nodes in the cycle packing are blue (or if they are all red), the solution is deemed unfair. Clearly, there are various ways of taking fairness into account, e.g., by adding a constraint, or by weighing this in the objective. In this project we want to develop efficient algorithms that lead to high-quality, fair solutions for various combinatorial-optimization problems, and we want to investigate trade-offs between fairness and quality of the solutions.

Appendix B: 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.

Appendix C: Information about the four institutions

TU Eindhoven

The TU Eindhoven (TU/e) is a technical university with nine departments, approximately 2000 scientific staff (including PhD students) and 8000 BSc and MSc students. The Department of Mathematics and Computer Science is the largest of these departments, offering several bachelor and master programs, all of which are taught in English. The TU/e campus is in the center of Eindhoven, a lively city in the heart of the high-tech industry in the Netherlands. Including suburbs, Eindhoven has about 400,000 inhabitants, making it the fifth largest city of the Netherlands. There is no need to own a car: within Eindhoven everything is reachable by bike, and other cities in the Netherlands can be easily reached by public transport.

More information:

- General information about TU/e and the Department of Mathematics and Computer Science
- Employment conditions at TU/e
- Support for internationals

University of Amsterdam

The University of Amsterdam is the Netherlands' largest university, offering the widest range of academic programmes. At the UvA, 30,000 students, 6,000 staff members and 3,000 PhD candidates study and work in a diverse range of fields, connected by a culture of curiosity. The UvA counts over a hundred different nationalities. The UvA is consistently ranked among the world's best universities in global rankings. It is a top 100 university in the THE Rankings, QS Rankings and Leiden Ranking. The UvA is also member of the League of European Research Universities and Universitas 21. The UvA is working to consolidate its teaching and research activities within four campuses including Amsterdam Science Park. Amsterdam Science Park is a centre for research innovation and entrepreneurship. Major research institutions are located here alongside about 120 companies and spin-offs.

- General information about UvA and the Faculty of Science
- Working at UvA
- The UvA in Amsterdam

Leiden University

Leiden University was founded in 1575. It is one of Europe's leading international research universities, with currently 31,000 students and 7100 staff, spread over locations in Leiden and The Hague. The university hosts 3000 international and exchange students each year, and has 1000 international PhD students and 800 international academic staff. Leiden University features among the top 100

universities in international rankings. Its membership in the League of European Research Universities is of particular strategic importance. The city of Leiden has 125,000 inhabitants and is known for its centuries-old architecture. University buildings are scattered throughout the city and students give the city a bustling and vivid atmosphere. The many important scientific discoveries made at the university over the past centuries have led to the motto: 'Leiden: City of Discoveries'.

- About Leiden university
- Working at Leiden University

Centrum Wiskunde & Informatica (CWI)
CWI is the Dutch national research institute for mathematics and computer science. Next to other research topics, main research themes are artificial intelligence, computation, data, networks, software, and quantum. By creating a synergy between mathematics and computer science, CWI pursues fundamental and long-term innovation and has been the birthplace of numerous pioneering breakthroughs. Our strength is discovering and developing new ideas that benefit society. Located at the Science Park of the vibrant city of Amsterdam, CWI is surrounded by many inspiring people and organizations. CWI plays a key role in academic networks, and maintains excellent relations with universities and industry. At CWI over 175 researchers conduct pioneering research and share their acquired knowledge with society. Over 30 researchers are also employed as professors at universities.

More information:

- General information about CWI
- Working at CWI