Summary 2015-2020 VU Computer Science

FACT SHEET

Research Staf

Year	2020	
Position	***Number***	***FTE***
Full Professor	12	10,9
Associate professor	6	5,3
Assistant Professor	26	24,6
Total Scientific Staff	44	40,8
Postdocs	17	16,4
PhD Students	101	89,4
Total PD + PHD	118	105,8

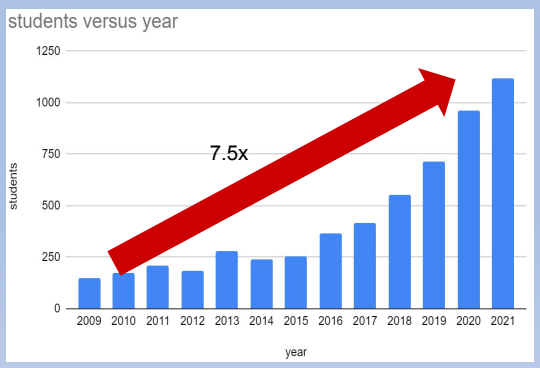
Gender Balance

Year	2020			
Gender	***F***		***M***	
Natnl./Intnl.	**Natnl**	**Intnl**	**Natnl**	**Intnl**
Professor	0	1	8	3
Associate Professor	2	0	1	3
Assistant Professor	2	2	7	15
Total Scientific Staff	4	3	16	21
Postdocs	2	2	6	7
PhD students	8	15	28	50
Total PD + PHD	10	17	34	57

Funding and expenditure

Year	2020	
Funding:		
	M€	%
Direct Funding (1GS)	11,0	55%
Research Grants (2GS)	4,5	23%
Contract Research (3GS)	4,3	22%
Total Funding	19,9	
Expenditure:		
Personnel costs	7,7	94%
Other costs	0,4	5%
Total expenditure	8,2	

Growth of Computer Science student numbers over the years



The **Department of Computer Science** of the Vrije Universiteit consists of 12 research groups collaborating on six themes: Artificial Intelligence, Bioinformatics, Computer Systems, User-Centric Data Science, Software and Sustainability, and Theoretical Computer Science. Compared to the previous assessment period, the department has benefited from the strongly increasing interest in AI, data science, and cybersecurity and from the "Sector Plan" investments in Dutch Computer Science research. The department also moved into a new building, with many modern labs. The intended co-location and integration with the Informatics Institute of the University of Amsterdam did not proceed, but we still have numerous research collaborations and joint MSc degrees.

Mission

The mission of the department is one of educating students and contributing to the development of our field by performing innovative research with high societal relevance. The department's research program is concerned with understanding the foundations, the mechanisms, and the technologies of software systems that scale, that behave intelligently, that are dependable, and that can be either autonomous or have humans in the loop. These systems are also applied to understand real-world data in various sectors. Our research is focused on scientific depth and we aim to lead in an international and highly competitive playing field. On top, the department strives to address questions about the inherent social relevance, value and nature of the technology itself. This is reflected in participation in inter- and multidisciplinary research contributing to various societal domains including humanities, social sciences, and health.

Strategy

Our strategic aims were (1) to perform top quality research on a broad set of key topics that form a coherent research program, without trying to cover the whole field and (2) to achieve high scientific and societal relevance of our work, by combining fundamental, strategic, and application-oriented research, resulting in publications and research software with high impact. Our research is focused on scientific depth and we aim to lead in an international and highly competitive playing field. We participate in inter- and multidisciplinary research contributing to various societal domains including humanities, social sciences, and health.

Our key strategic choices are to: attract top talent; optimize the internal cohesion and collaboration; form networks with key scientific and societal partners; invest in joint infrastructure; and achieve high societal relevance of our work. We optimized the internal cohesion by promoting and funding collaborations between researchers from different groups, specifically junior staff. Also, we invest in joint infrastructure and mid-level (associate professor) positions to stimulate collaboration. We aim for an open management structure. We form networks with key scientific and societal partners and have numerous strong (and often formalized) collaborations.

Scientific Impact

The department performs well and is able to attract and keep world class researchers that achieve both a high scientific impact and high societal relevance. We have numerous marks of recognition, such as many best papers at prestigious conferences, international PhD thesis awards, and much heavily used open source software and data sets. The department also is growing substantially and has been successful in obtaining prestigious grants such as NWO Gravity ("Zwaartekracht") program on Hybrid Intelligence. The various groups are well connected due to funding instruments and the flat structure; we also have many connections outside the department and outside our own field. Given these trends, the prospects for the future are good. Challenges include how to move to a hybrid working model, to adapt the organization to the steep growth of the department, to obtain a better gender balance, and to better monitor PhD performance.

Example 1: Societal Applications

The department of Computer Science has a long tradition of application of its research results for the benefit of society, in close collaboration with industrial partners, governmental organizations and NGOs. Notable examples include opening up and analyzing museum collections using modern computer techniques, making software usage more sustainable for the environment, ICT for developing countries, and improving software for the Dutch infrastructure.

Cultural heritage: Museums, libraries and archives take care of our cultural heritage. Designing sustainable digital representations of the heterogeneous and often subjective knowledge about cultural artefacts and the contexts in which people interact with these has been a central theme in our research. Recently, the renewed attention for data quality and data curation in the context of coping with bias in machine learning has resulted in new collaborations in this area, including User-Centeric Data Science's (UCDS) role in co-founding the ICAI lab on Cultural AI and the Culture & Media working group of the Dutch AI Coalition (NLAIC). In these initiatives we collaborate closely with both heritage institutions (National Library, Institute for Sound & Vision, Rijksmuseum), partners from the social sciences and humanities (KNAW HuC, VU History department, UvA Media Studies) and the Knowledge Representation & Reasoning group in our own department.

Software for environmental sustainability: The global cloud computing market is predicted to reach ~850 billion dollars by 2025. Cloud-based software has become a major consumer of energy, and energy consumption is increasing by >20% on a yearly basis. Society at large is increasingly dependable on reliable and efficient cloud software services across virtually all societal sectors. Since 2013, the Software and Sustainability Research Group has been performing research in collaboration with industrial and governmental organizations on the energy efficiency of cloud-based software. Example projects include: Cluster Green Software and Greening the Cloud (both MRA EFRO), studying the energy consumption of software- and data virtualization (e.g., with VMware), or different configurations of cloud-based applications (e.g., with KPMG, Software Improvement Group); GreenServe (RVO) piloting different software measures and the tradeoffs between performance and energy efficiency for cloud providers like Schuberg Philis and Equinix.

ICT4D: The field of ICT4D (Information and Communication Technologies for Development) addresses problems of, and solutions for, the "unconnected people in the world". Currently, this is close to half of the world's population, the majority of whom live in poor, remote, often rural, regions of the world. The UCDS and S2 groups join forces to apply their research in digital sustainability for ethical, ecologic and affordable data- and software applications; but also software that is tailored to the needs and limitations of many societal contexts. Long-lasting collaborations exist with Mali, Ghana, Burkina Faso and Sarawak (Malaysia).

Software for infrastructure: Rijkswaterstaat is responsible for infrastructure like roads, bridges and dikes in the Netherlands. Control software to guarantee safe operation is of crucial importance in this context, and problems with such software has caused many problems and delays over the years. Since 2015, the Theoretical Computer Science group at the VU is optimizing and applying a formal technique called supervisor synthesis to automatically generate correct controller software from the functional system requirements. Important case studies are the Algera complex over the river IJssel, combining a lock, a bridge and two storm surge barriers, and the King Willem Alexander tunnel at the

city of Maastricht, the first two-layered roadway tunnel in the Netherlands.

Example 2: AI - Hybrid Intelligence and AI in Health

The **Hybrid Intelligence Center** was awarded a "Zwaartekracht" ("Gravitation") grant, under the leadership of VU Professor Frank van Harmelen, of €20 M for 10 years in the 2019 selection round, making the HI Center the largest grant for AI research ever awarded in the Netherlands at that moment. The VU has heavily invested in its role as a coordinator of the HI Center, with a matching grant of €3 M over 10 years, to be spent on additional PhD and postdoc positions. In addition, the department has allocated one of its sector plan positions (tenure-track assistant professor position) to Hybrid Intelligence.

The central question of the center is: how to build AI systems that collaborate with people instead of replacing them. Hybrid Intelligence (HI) is the combination of human and machine intelligence, expanding human intellect instead of replacing it. Developing HI needs fundamentally new solutions to core research problems in AI: although current AI technology surpasses humans in many pattern recognition and machine learning tasks, it falls short on general world knowledge, common sense reasoning, and human capabilities such as collaboration, adaptivity, responsibility and explainability.

The HI Center runs an educational programme for PhD candidates in collaboration with the national research School for Information and Knowledge Systems (SIKS), as well as an international internship programme in collaboration with the EU-funded HumanE AI Net (covering 53 institutions across 20 European countries), for which each PhD candidate is awarded a travel budget.

The 27 positions recruited in 2020 have been filled with strong attention to gender diversity, resulting in 55% female recruits among our PhD candidates and postdocs, as well as cultural diversity, with recruits from Turkey, Vietnam, India, Mexico, Korea and many parts of Europe, including former Eastern-European countries.

AI in Health is one of the prominent societal application domains of the Department of Computer Science, predominantly for research related to artificial intelligence (AI) and bioinformatics. While there is a high promise in AI and Health, the number of AI-driven solutions that make it to the patient is still limited. To optimize this, the Department has initiated two collaborative platforms, the *VU Campus Center for AI and Health* and *Amsterdam Medical Data Science*. These initiatives nicely align with one of the ambitions of the Amsterdam AI Coalition, which aims to become the leading hub for AI and Health research in the Netherlands and one of the leading hubs in Europe.

The VU Campus Center for AI and Health was founded in October 2020 to stimulate interdisciplinary research in the area, building on a longstanding tradition of over a decade of informal collaborations with health-related researchers on the campus. The center brings together three academic institutes on the VU Campus: the VU, the Amsterdam University Medical Center, and ACTA (Dentistry). It is supported by the boards of these three institutes.

The central goal is to improve health care by developing, implementing and evaluating AI technologies. In total over 60 senior researchers participate in the center that spans across 6 faculties, including our staff members from Bioinformatics, Computational Intelligence, Knowledge Representation & Reasoning, Social AI, and Quantitative Data Analytics. Dozens of PhD candidates and Postdocs partake in the center.

Research is organized according to three pillars:

- Technological challenges - innovative research on AI to improve its suitability for health;
- Health challenges - studying how AI techniques can improve care;
- Implementation challenges – studying how AI driven technology can best be embedded in organizations and what their impact is on the organization.

Next to this research-based organization, our department is also one of the founding partners of Amsterdam Medical Data Science (AMDS), a platform for researchers, health care professionals, and data scientists with nearly 2000 members that organizes regular (monthly) meetups to exchange insights into AI and Health. The initiative spans across the entire Amsterdam metropolitan area. The two initiatives complement each other and contribute to improve training of PhD candidates, e.g., in joint courses, enabling more interaction and knowledge exchange between disciplines. This way, AI and Health is to create true societal impact, to bring AI to the patient, but also to understand what AI innovations are still needed to reach that goal.