

Europe Needs Strong Software Research

“Software is eating the world.”¹ Indeed, just like oxygen is an invisible but essential element for all life forms, software is an essential, yet invisible, driving force of the present world:

- Software is the fabric of our society: there’s virtually no aspect of society that is not facilitated or mediated by software;²
- Software is a key transformation and enabling technology, disrupting many areas of modern economy, compelling industry leaders to admit that “every company is now a software company”;³
- Software boosts scientific progress in many domains (e.g., AI, data science, medicine, engineering);
- Software is vital for our infrastructure as it underlies critical systems (e.g., power, telecom, aerospace, automotive, finance, health);
- The total volume of software in the world is staggeringly large, and is growing at an exponential rate⁴.

There is, however, a striking contrast between, on the one hand, the omnipresence of software in our society and, on the other hand, the extraordinary difficulty to guarantee the correctness, reliability, performance, scalability, safety, and sustainability of modern software systems. There is an urgent need for software engineering innovations: the world of software is a moving target, due to the ever-increasing size and complexity of software, the technological churn of both hardware and software, the increased heterogeneity of software, and the emergence of new societal and technological challenges⁵. Fostering such innovations requires fundamental software research, independently of specific application areas (e.g., blockchain, AI, Internet of Things, quantum computing, etc.). Only then can we continue to further develop the concepts and technologies that have revolutionized how we build software (in no small

¹Marc Andreessen, “Why Software Is Eating the World”, The Wall Street Journal, August 20, 2011. See: <https://a16z.com/2011/08/20/why-software-is-eating-the-world>.

²Software was responsible for 1 trillion euro of total value-added GDP in 2016, a 9.9% increase with respect to 2014, whereas the overall GDP growth over the same period was 6.0%. Source: <https://software.org/reports/2018-eu-software-impact/>

³For instance, Satya Nadella, CEO of Microsoft, at the Mobile World Congress, 2019. See also: “Now Every Company Is A Software Company”, *Forbes*, November 30, 2011.

⁴Recent research estimates the global volume of software to double every 3.5 years on average. See: Hatton, et al. “The long-term growth rate of evolving software: Empirical results and implications” *Journal of Software: Evolution and Process*. February 2017.

⁵Diomidis Spinellis, “Research Priorities in the area of Software Technologies”, *EU DG Communications Networks, Content and Technology — E2 PO 30-CE-0751856/00-91*, 2016.

part due to European innovations, such as the World-Wide Web, the Linux operating system, and the Python programming language).

Europe is home to the expertise that is required to lead and drive innovation in software. It hosts some of the most talented software researchers at universities, research institutes, and R&D departments in industry. However, the software research community lacks the resources to facilitate basic research and bootstrap public-private collaborations between industry and knowledge institutions. As a result, software innovation is stifled, and Europe risks becoming a second-hand user of innovations invented elsewhere⁶, esp. from big tech from America and Asia. European industry is gradually becoming less competitive as software is the key differentiating and value-adding factor in products and services. This is not only detrimental to Europe's economy, but also affects Europe's autonomy and sovereignty at the strategic level. Since software reflects and shapes society, core values, such as privacy, safety, fairness, sustainability and inclusion, are increasingly under threat. We therefore urgently request that European and national funding agencies acknowledge the importance of software for society and the need for software research. Now is the time for generous funding instruments for software research, and leveraging the expertise that Europe has to offer, to remain autonomous and stay ahead of the curve.

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- VERSEN (<https://www.versen.nl/>)
- GDR GPL (<https://gdr-gpl.cnrs.fr/>)
- TIVIA (<https://tivia.fi/in-english/>)

⁶Over the past 10 years (up to 2018), R&D investments of European software companies grew only by 5%, whereas the R&D spending of US software companies grew faster at a rate of 8.2%. Source: Networked European Software and Services Initiative (NESSI), Next Generation Software Technologies Empowering the Digital Transformation of Europe: Recommendations on Software Technology Research for Horizon Europe, 2018.

Endorsements and Signatories

Endorsements by organisations

- VERSEN: VEReniging Software Engineering Nederland (VERSEN) is the Dutch National Association for Software Engineering. Its mission is to bring together researchers, educators and practitioners in the field of software engineering in The Netherlands (<https://www.versen.nl/>).
- Groupement de Recherche Génie de la Programmation et du Logiciel (GDR GPL). The GDR GPL is an association of INS21 of CNRS to bring together the French scientific community researching software engineering and programming (<https://gdr-gpl.cnrs.fr/>).
- The Formal Methods Europe association is an interest organisation for academic and industrial work in formal methods. We arrange the flagship Formal Methods Symposia and the FormaliSE conference (<https://www.fmeurope.org/>)
- The European Association for Programming Languages and Systems (EAPLS) promotes research in the area of programming languages and systems, including the dissemination of information and the organisation of conferences (<https://eapls.org/>).
- Centrum Wiskunde & Informatica (CWI, <https://www.cwi.nl>), the Dutch National Research Institute in Mathematics and Computer Science.
- ERCIM - the European Research Consortium for Informatics and Mathematics - aims to foster collaborative work within the European research community and to increase co-operation with European industry. Leading European research institutes are members of ERCIM (<https://www.ercim.eu/>)

Quotes by signatories

Research and education are fantastic for the future prosperity of our continent in this digital era!

Peter Jacobs, Senior Partner at McKinsey & Company

Trustworthy digitalization and AI fundamentally depend on trustworthy software. We need software research.

Arie van Deursen, Professor of Software Engineering, TU Delft, The Netherlands.

Software is key to everything we do, from shopping to healthcare to science. We need to ensure research into the engineering of software is adequately funded.

Steffen Zschaler, Reader in Software Engineering, King's College London, UK

As a researcher working in the European software industry on innovative software projects, I can attest that strong funding of software research is extremely important for Europe's competitiveness.

Manuel Chakravarty, Research & Architect, Tweag I/O and Input Output (IOHK), Netherlands

Great initiative! Some years ago I was the vice-chair of DG Connect Advisory Forum and we often discussed this problem and recommended to the Commission that they should support software directly. And as someone said: Software is everywhere but nowhere!

Ole Lehrmann Madsen, Professor of Computer Science, Aarhus University, Denmark

This is long time overdue! Europe cannot be behind Americas and Asia on that, and this definitely requires more funding for SE research.

Massimiliano Di Penta, Professor of Computer Science, University of Sannio, Italy

Software is really eating the world. And it can be so helpful to adress many current and future world, societal, economic and scientific challenges . Let's make it happen!

Bernhard Rumpe, Professor of Software Engineering, RWTH Aachen University, Germany

As a key enabler for the development of our economy and society, yes we need more re-search on software.

Lionel Seinturier, Professor of Computer Science, University of Lille & INRIA, France

Software is not magic. It has to evolve to meet changing society. We need more research on improving software decay and evolution.

Stéphane Ducasse, Research Director INRIA Lille Nord Europe, France

The scientific study of the foundations of reliable software and software construction is essential. Such research can be inspired, but should not be dominated, by innovations in its application domains.

Jaco van de Pol, Professor of Computer Science, Aarhus University, Denmark

Let's do it now for a better tomorrow.

Ayushi Rastogi, Assistant Professor of Software Engineering, University of Groningen, The Netherlands

Research on the foundations of future reliable and resilient software systems is fundamental for Europe. Investing in it should be a priority.

Luca Aceto, Professor of Computer Science, Reykjavik University, Iceland

Software research was identified as the top strategic area for public research investment during Clinton's administration. European software research has a very strong international standing and track record in treating software as a thing in its own right: something that gets built, controls the physical environment, facilitates – not just aids – digitalization and, most of all, needs to be predictable and guaranteed safe and secure. Yet it is still treated as an appendix to hardware in European research programs, even though their roles have de facto reversed. Will European research funding agents, stakeholders and industrial decision makers habitually continue to think of a car as an electro-mechanical devise with some embedded software – or recognize it is a software-controlled computer with peripheral devices, where the software is the key component?

Fritz Henglein, Professor of Computer Science, University of Copenhagen, Denmark

CWI has been involved with software research since it was established in 1946. From algorithms to databases, from programming languages (e.g., Python), to machine learning libraries, – many scientific contributions of CWI are in the field of software engineering or adjacent fields. CWI furthermore stimulates publishing open source software and seeing software as a form of scientific output. We therefore wholeheartedly acknowledge the importance of software for a strong Europe, and endorse this call for increased funding of software research.

Ton de Kok, Director Centrum Wiskunde & Informatica (CWI), The Netherlands

Many companies invest into software research, in particular formal methods, to deliver high quality products for applications like autonomous driving, aviation, medical applications, and other missing critical embedded systems. It's absolutely crucial to fund foundational research in these areas to push the envelope and develop stronger methods that are at the same time easier to apply in practice.

Peter Thiemann, Professor of Computer Science, University of Freiburg, Germany

Software is not a "solved problem". In fact, research on software is essential to move society towards the future!

Einar Broch Johnsen, Professor of Informatics, University of Oslo, Sweden

Europe needs strong software research. Software is everywhere nowadays. It is at the heart of society, and I think we are just starting!

Nelly Bencomo, Associate Professor of Computer Science, Durham University, UK

Software is central to almost any innovation in society. Studying how software is developed is essential for improving and simplifying the development of software.

Johan Jeuring, Professor of Software Technology, Utrecht University, The Netherlands

Independent funding and research is needed to help develop software research. This is too important to be left to private means. Our societies depend on correctly functioning software to drive our services, businesses and support technology. It's time to be bold and it's time to invest.

John Moss, British Computer Society

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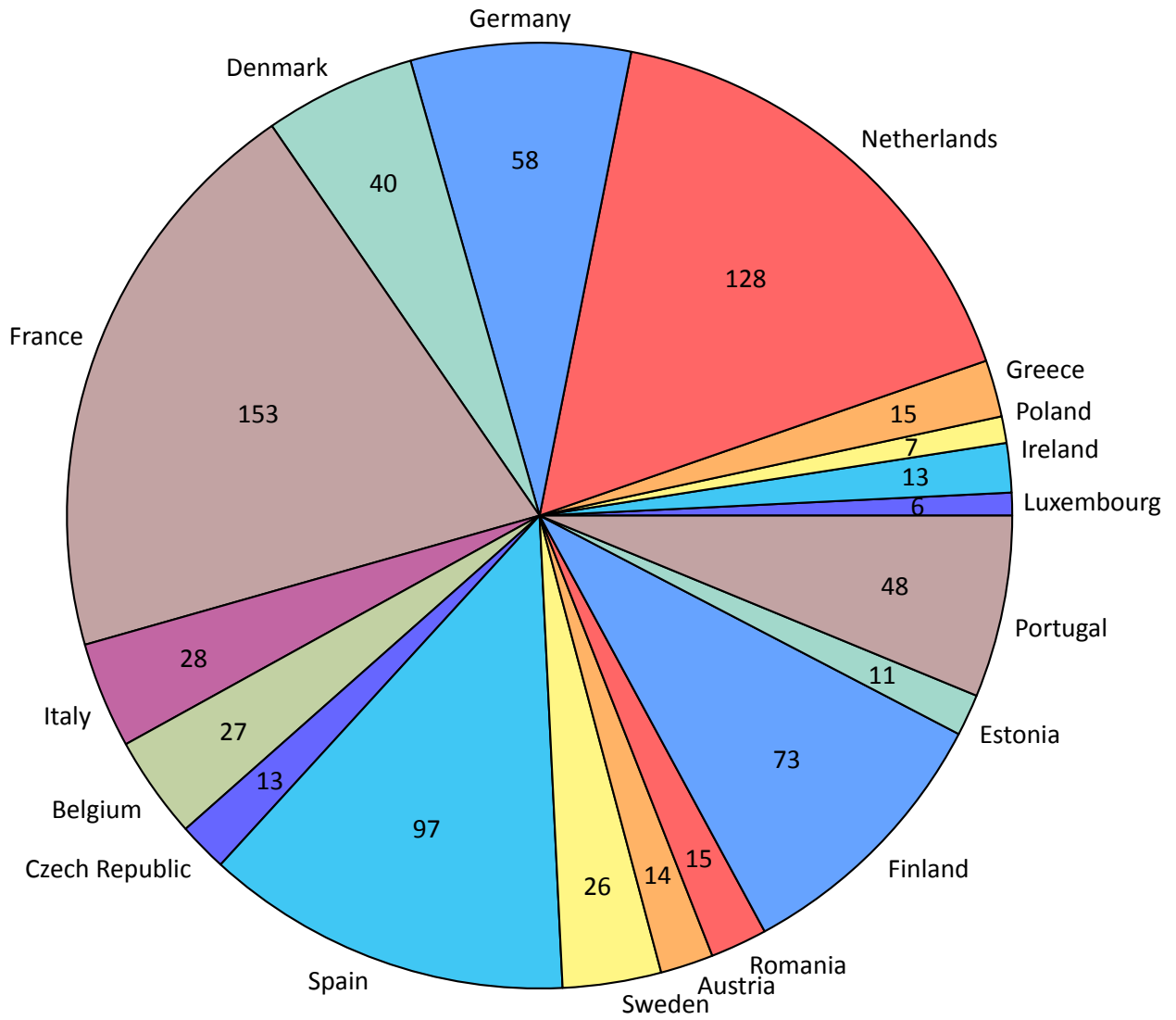
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