Funding research in computer science

Richard Starmans (UU) and John-Jules Meyer (UU)

Introduction

In studying and accounting for developments in science, its history and foundations, traditionally two distinct and extreme approaches are recognizable. A purely *internalist* approach studies science as a sequence of new discoveries, ideas, theories, observations, experiments and theory revisions, without taking into account its context. Cultural, political and commercial considerations on power, funding organizations, industrial involvement and conflicting interests of stakeholders and institutions are of no concern. Science is to be considered a rational and essentially value-free activity, which should be scrutinized and understood as such. This tradition started in the nineteenth century with William Whewell's famous monograph "History of the inductive sciences" (1837) and dominated history of science for a long time. In the Netherlands, Dijksterhuis' classical study "De mechanisering van het wereldbeeld" (1950) is generally considered to be a milestone in this tradition. On the other hand, one could also take an *externalist* stance by taking the historical, cultural and social context of the scientific enterprise into account. From this point of view one cannot fully understand or give a good account of science without knowing its environment, institutions and stakeholders, their values and interests. One of the pioneering works in this tradition was Robert K. Merton's doctoral dissertation "Science, technology and society in seventeenth-century England" (1938), explaining the scientific revolution in the 16th and 17th century in the context of English puritan orthodoxy. A nowadays less appreciated example is Boris Hessen's notorious interpretation of Newton's Principia Mathematica, claiming that Newton's physics was just a mere attempt to serve the interests of the bourgeois class. Also the philosophers from the Frankfurter Schule habitually followed this line of argument, claiming science to be an essentially not value-free activity, primarily serving the interests of the ruling class. More mitigated, balanced and far more prominent was Thomas Kuhn's "The structure of scientific revolutions" (1962) according to the Guardian one of the 100 most influential books of the 20th century. After Kuhn's, Paul Feyerabend's, and more recently Bruno Latour's work, many philosophers of science are inclined to agree that a full picture of the scientific enterprise should integrate elements from both the internalist and exernalist tradition.

Now, one need not exhibit a full and unconditional adherence to an extreme externalist position, to appreciate the idea that science is a human activity with many stakeholders, especially in a technological/engineering discipline like computer science. To name a few: the federal government, specific ministries, publicly financed research institutions, the European committee, the ICT-branch, and of course universities, departments and, the researchers themselves. Identification of the different types of stakeholders, their roles, interests, including their (financial) participation and involvement is worthwhile for several reasons. Those committed to safeguarding academic independence and integrity will undoubtedly refer to medical and pharmaceutical research, were the interests of companies producing pharmaceuticals or medical equipment, involved in financing and conducting experiments, have to be reported explicitly, and are watched closely by ethical committees following strict protocols and codes of conduct.

But apart from this ethical aspect, knowledge of the environment may also help to understand and assess current state of affairs in a research area, and it may facilitate policy makers and researchers to better anticipate on coming developments, both opportunities and threads. It may give information about the structure of the field, indicate the relative success of certain subfields or research programs, their international position and orientation, as well as their intended or alleged relevance for industrial companies or society as a whole, etc. This article is based on the assumption that a detailed analysis of the environment, its institutions and stakeholders, including different ways of funding in the field of computer science, can contribute to our understanding of the field and the assessment of its current state.

Aim

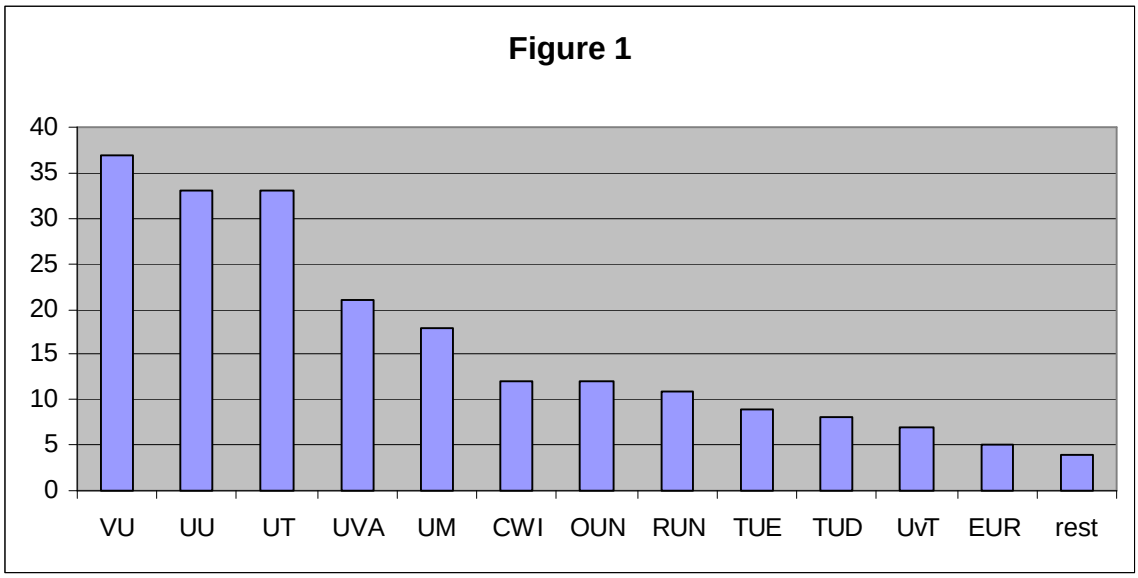
In this paper, we obviously cannot cover the entire research in information and computing sciences, but we confine ourselves to the research on information and knowledge systems (IKS), which still is a broad field. As a first explorative step towards this wished insight in the current state of IKS-research in the Netherlands, we will here examine how a large number of phd-projects were funded, which stakeholders/ institutions were involved, under which funding conditions the projects took place and relate these findings to the structure of the field as will be described in the next section.

Population

To this aim we examined the project-data of over 300 researchers working in the IKS-field. These researchers had two things in common; they were all involved in phd-research in the Netherlands in the period 1998-2006 and in the same period they were all registered in the National Dutch Research School for Information and Knowledge Systems (SIKS). Founded in the mid-nineties by researchers in the field of Artificial Intelligence, Databases / Information Systems and Software Engineering, SIKS currently identifies eight research themes:

- Agent technology
- Computational Intelligence
- Knowledge Representation and Reasoning
- Web-based information systems
- E-business systems
- Human computer interaction
- Data management, storage and retrieval
- Architecture-driven system development

The over 300 researchers were employed at ten universities and the CWI. Although our research population is not a full representation of all research conducted in IKS in the Netherlands, it is sufficiently representative for our explorative purposes in this paper. As a first orientation, Figure 1 shows how in 2006 about 200 IKS-projects (ongoing projects and projects completed in 2006) were distributed over the participating universities.



Method

Project-data of 300 IKS-research projects, all conducted between 1998 and 2006, or currently being conducted in the Netherlands, were provided by the administrative offices of the participating universities and were enriched with data obtained from the SIKS-monitor, a large scale continuous survey among the phd-researchers, explicating the research-profiles of all individual researchers and the structure of the IKS-field in the Netherlands. [Starmans, 2005]. For each project we tried to answer the following related questions:

- On which formal money flows was the project based?
- Which stakeholders / third parties were involved and how?
- How was the research funding acquired (internal, external competition, no competition, other allocation mechanisms)?
- Which financial conditions were reported (matched funding, co-funding)?
- Which content involvement/conditions were reported (fundamental versus applied, specific versus generic program, etc)

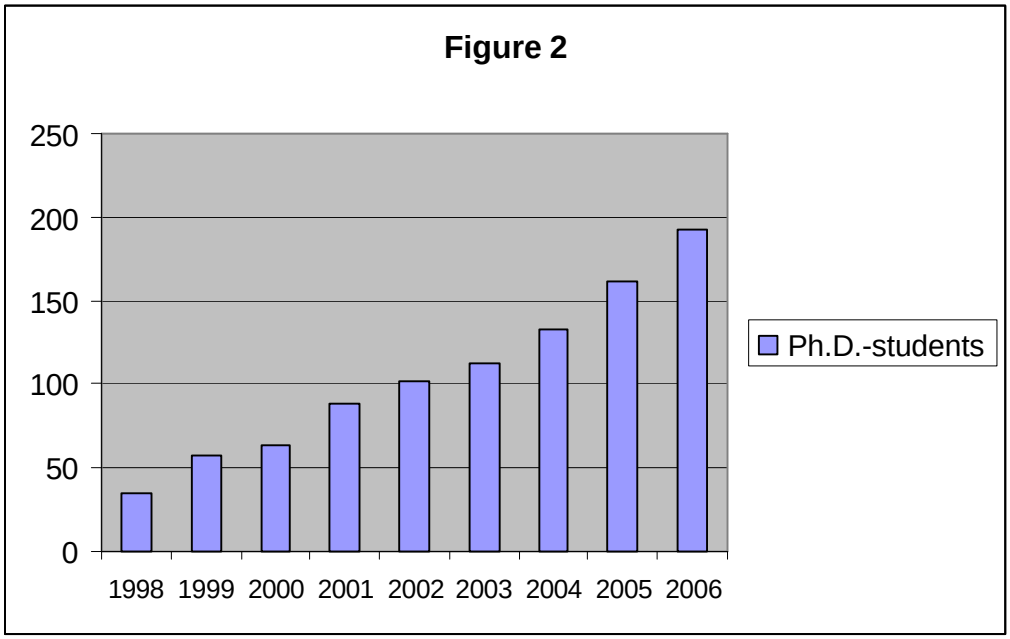
To answer the first question we first categorized each project as a first, second or third money flow project. First money flow projects (=first flow of funding projects) usually refer to *indirect* research funding by the government through the universities. Universities first acquire funding from the government and then apply some allocation model to divide the money over faculties, research groups, enabling them to employ permanent staff and phd-researchers. Often no (internal) competition is organized at the universities to divide the financial means. Also, typically no specific constraints / requirements regarding content, relevance and applicability are reported and no external stakeholders are involved in the projects.

Second-money flow projects (=second flow of funding projects) usually refer to government funding, channeled directly into research through NWO or STW. Typically, researchers or research groups acquire this funding after a national competition.

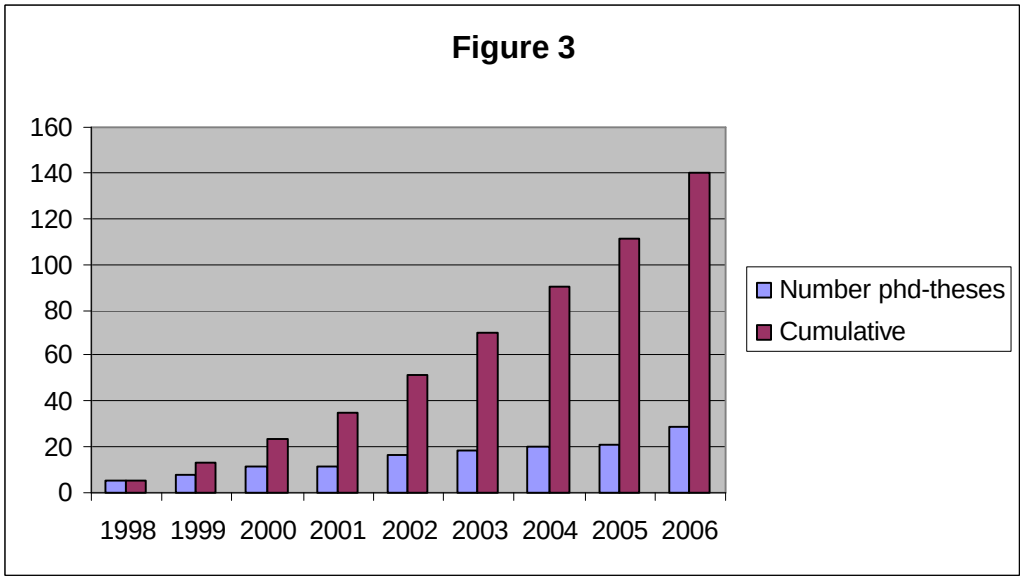
In NWO there are general programs with no specific program requirements (for example the Open competition), but also special interest subsidiary programs, dedicated to specific research themes. Obviously, the latter category by definition has conditions

related to the content of research proposals. In STW typically several external users play a role in the project.
Third money flow-projects (=third flow of funding projects) include all projects funded by other resources. Usually, this very heterogeneous term refers to research funding acquired through contracts with third parties such as governments, ministries of Economic Affairs, European Union, European Committee, private foundations, individual companies, consortia of companies, charitable boards and other non-profit organisations, research organisations like TNO, etc. Due to the diversity of this category, general statements about competitions cannot be easily made, with the exception of European funding, of course. Typically, in third money flow projects several stakeholders are involved and many projects are focused on applied research. Our definition of third money flow implies that all European projects are part of it, although it is sometimes informally called the “fourth money flow”, which we do not adopt here.
On the one hand this classification is not that informative anymore; the landscape of funding organisations, grants, subsidiary programs and instruments has rapidly grown complex over the last decade. We report it here, because it is still commonly used and gives a global impression already. However, to give a full picture and answer the remaining questions, the second and third money flow will be further analyzed or subdivided.
Therefore, as a second step we also checked for each second or third money flow project in our population what organisations were involved and in which program the projects participated. Special attention will be paid to the category of European funded projects, which formally belong to the third flow of funding.
As a third step we enriched the data with survey-data obtained from the SIKS-monitor, that tracks developments in the IKS-field, provides profiles of individual researchers and groups and identifies the structure in the field. The detailed characteristics provided by the IKS-monitor enable us to relate specific trends in funding to specific research areas in the IKS-field. In this short paper we will confine ourselves to some global comparisons.

Main results
The obtained data allow for some straightforward and immediate global conclusions for the IKS-field. First and foremost, we observe that the period of the last 8 years shows a rather spectacular and unprecedented growth of IKS-research projects conducted at Dutch universities. Starting with 35 Ph.D.-students in 1998, currently over 190 researchers are conducting IKS-research. See Figure 2.



Even if we acknowledge that the IKS-field might be somewhat underrepresented in our data with respect to the late nineties, this will not brush away the strong rise of the last five years. The real rise in projects started in 2001 and with a time delay of 4 to 5 years, the results are visible in the number of successfully defended dissertations. The clustered bar chart of Figure 3 shows the annual growth of doctoral dissertations as well as the cumulative numbers over the period 1998-2006.



Secondly, it goes without saying that this rise in projects is only possible with a substantial raise of funding sources in the scientific community. Indeed, the plethora of funding sources that emerged in the last decade, can all be reduced to the three categories of first, second and third money flow. We tracked the relative importance of these three money flows over a period of nine years, resulting in the stacked bar chart of Figure 4, which for our purposes is quite illustrative.

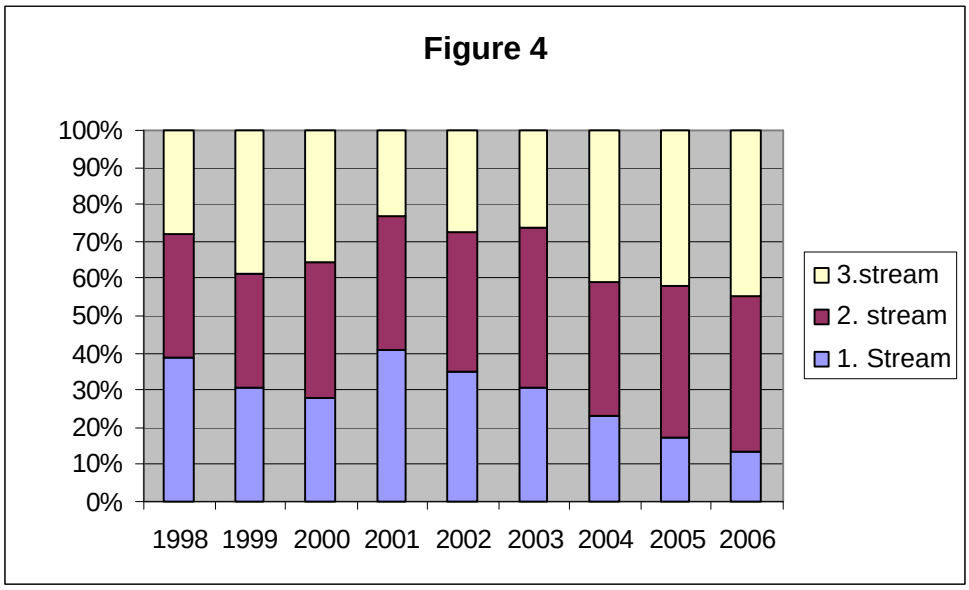


Figure 4 positively shows a dramatic decrease in first money flow financed projects over the last few years. It dropped from 41% in 2001 to only 13% in 2006. A closer look at the data confirms that this trend is only slightly attributable to the rise in second and third money flow projects. Also the absolute numbers confirm that universities more and more do not spend their first money flow resources to fund phd-research. This applies to all IKS-sub areas: AI-research, databases/information systems and software engineering. Figure 4 also indicates that the share of second money flow funding appears rather stable for a period of several years; it varies from 35% till 40%. Clearly, this means that the growth of NWO and STW-funded research is proportional to the growth of the population of all projects. So, combining Figure 2 and Figure 4 we can infer that the absolute growth of second money flow funding of IKS-research is quite substantial! The third money flow strongly increased in the last period. In 2006 over 40% of the projects were funded this way. Considering the strong growth of the population, this means that in absolute numbers the rise of third money flow funding increased even stronger. In fact, compared with 1998 the number of third money flow projects in 2006 increased with a factor of 8 to 9.

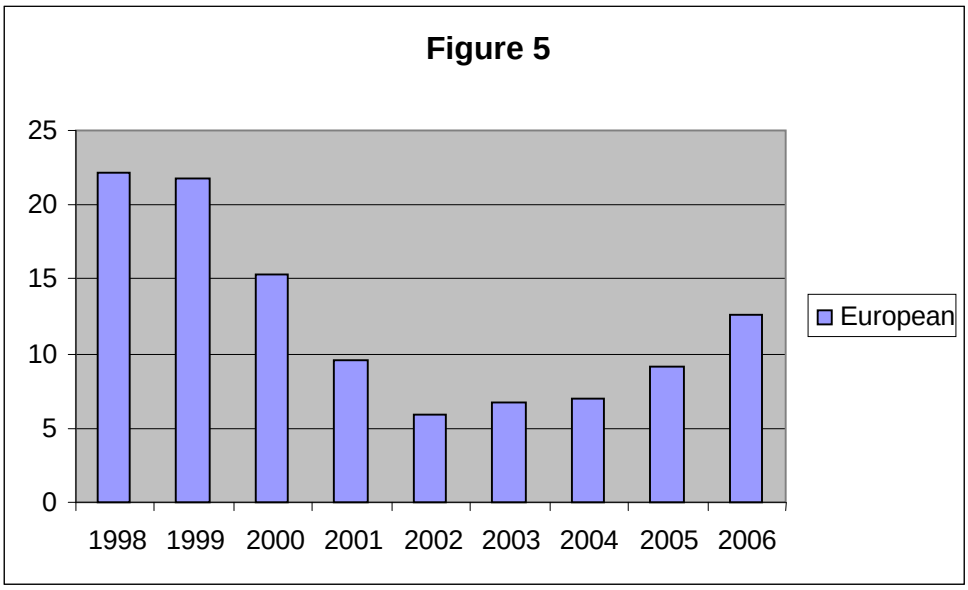
To perform our second step we have a closer look at the data of the second and third flow projects. Regarding the second flow this situation is rather straightforward. In fact, there are relatively few STW-financed projects; the vast majority is fully NWO-funded. Restricting ourselves to the current population of all registered phd-students in 2006, including those who graduated this year, we observe that in the second money flow IKS-research depends heavily on

- The Open competition
- Personal programs (VIDI, VICI, in the recent past: PIONIER)
- Special interest programs like
    - TOKEN:Toegankelijkheid en Kennisontsluiting in Nederland 2000
    - CATCH: Continuous Access To Cultural Heritage
    - JACQUARD: Joint Academic and Commercial Quality Research and Development (Softwatre Engineering
    - CLS: Computational Life Sciences

This list indicates that several important IKS-areas are recognized by/represented in the NWO-special interest programs, but these programs do not cover the entire IKS-field.

Regarding the increase of third money flow our main observation is that for sure this rise is not accounted for by participation in European projects. On the contrary, figure 5 shows a very modest role for this funding source in the IKS-field.

Figure 5



In the late nineties the percentage was rather substantial, it dropped in 2002 to nearly 6 % of all funded projects (first, second and third money flow) and then slowly increased to 12% in 2006. The latter trend may seem encouraging, but it is clear that participation of IKS-research in the Netherlands is very small. This is not unlike the situation in the entire field of information and computing sciences in our country. The NOAG-ict 2005 shows a strong concern about a weak participation of Dutch computer science research in European funded projects. [NOAG-ICT,2005]

So, definitely the strong rise of third money flow based projects cannot be traced back to participation in European projects. Interestingly, it is not caused by cooperation between research groups and individual companies either. Contract research, based on bilateral agreements between a company and a research group c.q. researcher as to financing phd-research is hardly manifest in the IKS-field as represented by our data.
In fact, the real impulse to third money flow funded phd research is due to the installation of so called BSIK-consortia. This acronym stands for 'Besluit Subsidies Investeringen Kennisinfrastructuur'. Giving shape to the idea of a “knowledge economy” the Dutch government started investing some of the earnings of its natural gas reserves into its economy's infrastructure. In recognition of the fact that scientific knowledge is part of a modern economy's infrastructure, part of the funds are reserved for strengthening the research and development capacity in the Netherlands.
In 2003, an ambitious program to subsidize investments in knowledge infrastructure ('BSIK) was created. The BSIK scheme aims to bring together parties from public research and industry into BSIK-consortia and support their joint research efforts with funding of up to 50 percent. A total budget of EUR 802 million is available for research

proposals focusing on one of five multidisciplinary themes, which are considered to be highly relevant for the economy and the Dutch society as a whole: information and communication technology is one of these themes.

Restricting ourselves to the current IKS-population of 2006 we observe that the following four BSIK consortia substantially triggered the rise of third money:

- BRICKS (Basic Research in Informatics for Creating the Knowledge Society)
- ICIS (Interactive Collaborative Information Systems)
- MULTIMEDIAN (Multimedian Netherlands)
- BIORANGE (Bioinformatics)

Similar to the NWO-special interest programs, these consortia indicate that they are important for specific sub areas in the IKS-field, but do not cover it completely.

Conclusions

Undeniably research in IKS flourishes, witnessing a spectacular growth of phd-projects and finished dissertations. The latter number is expected to increase even further the coming years. However, typically most of the funding is *non-structural*. Especially, the third money flow projects depend heavily on the economic situation and there is no guarantee that BSIK-consortia (or its successors) will be continued at the same level the next years. For the near future, the SMARTMIX-program offers some interesting opportunities for specific subfields in IKS, but basically here the same argument applies. Apart from its non-structural character the strong dependency on third money funding may have some other disadvantages, especially in combination with the strong decrease in first-money flow projects. Typically, third money projects, unlike first money research, have several stakeholders and they tend to favor more applied research. And, they often demand matched funding, which means that faculties, in order to meet this financial prerequisite, temporally buy out their permanent staff, to supervise and participate in the more applied third money flow projects. One could state that the rise in third money flow may occur at the expense of first money stream research.

A third conclusion is that sub areas in IKS field may run into trouble if they do not succeed in establishing / participating in a BSIK-consortium or NWO-funded special interest program. For example Artificial intelligence, Computational Intelligence, Web-based systems, Database technology are highly successful, but they do not represent the entire IKS-field. Especially if a research area lacks its own BSIK-project or NWO-program, also fails in attracting European funding and depends strongly on the evaporating first money stream, it may run into trouble.

We will refrain here from trying to explain the small participation of IKS-research in European projects. Maybe the cumbersome and time-consuming application procedures associated with international competitions do play a role, but a more thorough and qualitative examination should complement our exploratory steps to account for this. However, one could imagine that research areas or groups that fail to attract money in the aforementioned national programs (now or in future) might consider stepping into international competitions. In fact, the KP7-program of the European Union, that starts as of 2007 offers some interesting opportunities for IKS-research.

References

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