# THE WIDE ROLE OF INFORMATICS AT UNIVERSITIES

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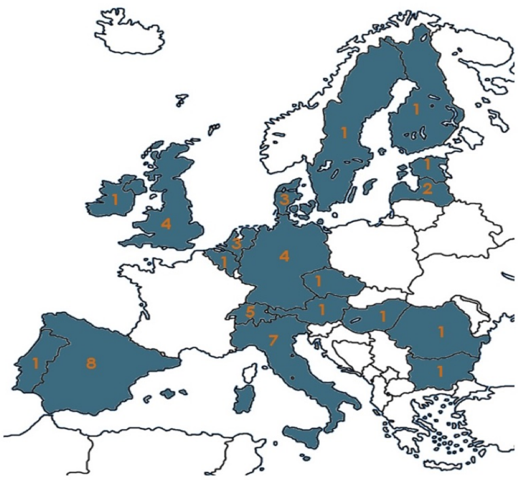
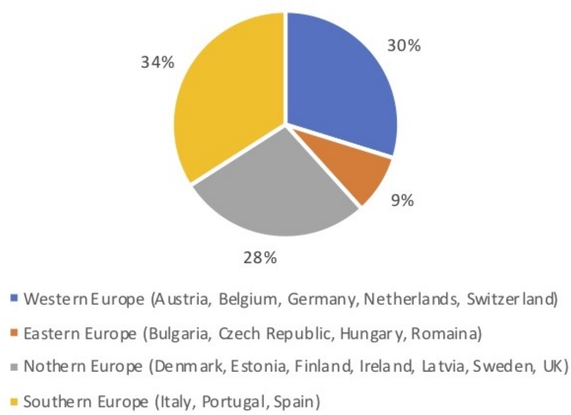
## 1. Introduction

In the 1970s with the advent of the personal computer we entered into the Digital or Information Age. However it has only been in this century with the ubiquity of the internet, the smartphone, and the internet of things that digital has become truly pervasive. How do universities respond to this massive change? Informatics Europe established in 2018 a new working group to investigate what universities are doing to ensure that non-informatics teaching and research is informed by best practice in Informatics.

To better understand the state of affairs on this topic and discover best practices at European Universities, the working group conducted an online survey. We invited heads and members of Informatics/Computer Science/IT Departments (Schools, Faculties, Institutes) to complete a questionnaire in autumn 2018. The request to fill out our survey was sent to all Informatics Europe members and it was also publicly available from the Informatics Europe website. For the location of the respondents see Figure 1. Forty eight universities from nineteen countries filled it out (see Appendix B).




(a) Countries




(b) Regions

Figure 1. Location of Respondents

Our survey was wide ranging. We wanted to understand how universities valued interdisciplinary research, about teaching Informatics to non-specialist students, what happens in practice with hiring and supporting interdisciplinary academics, and what structures are in place to support interdisciplinary work. We chose to examine Data Science's impact in detail, given its importance and newness. For the actual survey questions see Appendix A.

Although how Informatics (also called Computer Science or Computing) should position itself in a university is a political decision, in many universities what happens has arisen organically rather than strategically. There are a wide range of models with the extremes ranging from primarily being a service department to being primarily a research area that is isolated from other departments.

## 2. Research

Universities are normally structured into disciplines which foster disciplinary research. However, the ubiquity of Informatics in our culture has led to pressures for research that is interdiscipline. Pressures in favour of such research comes from academics themselves, external funding sources, and sometimes from university leadership. The following subsections discuss the answers obtained for each specific question.

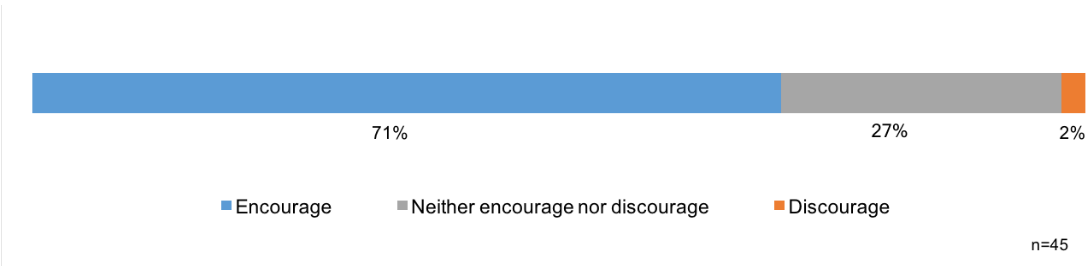



Figure 2. What is the University attitude towards Interdisciplinary research?

2.1. **Desirability of interdisciplinary research.** The first part of the survey questioned respondents on university attitudes and actions in respect of interdisciplinary research. A large majority (71%) claimed that their university encouraged interdisciplinary research when compared with single discipline research (see Figure 2). This seems to imply that universities favour interdisciplinary research over single discipline research. However, several respondents indicated that their encouragement was largely 'theoretical' and accompanied by little, if any, funding. Some respondents said that much of the interdisciplinary work at their institution occurred between departments other than Informatics. Only one respondent indicated that their university actually discouraged interdisciplinary research although others mentioned that their departments were judged, usually nationally, against discipline-specific criteria.

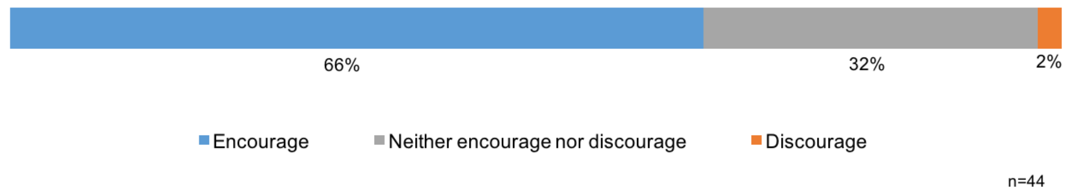



FIGURE 3. What is the Department attitude towards interdisciplinary research?

2.2. **Department attitude towards Interdisciplinary research.** With the same question directed at Informatics Departments rather than the whole university (see Figure 3), two thirds of respondents still claimed that interdisciplinary research was favoured over single discipline topics. However, similar comments are made about encouragement being in principle rather than in practice and about being judged on discipline-specific criteria.

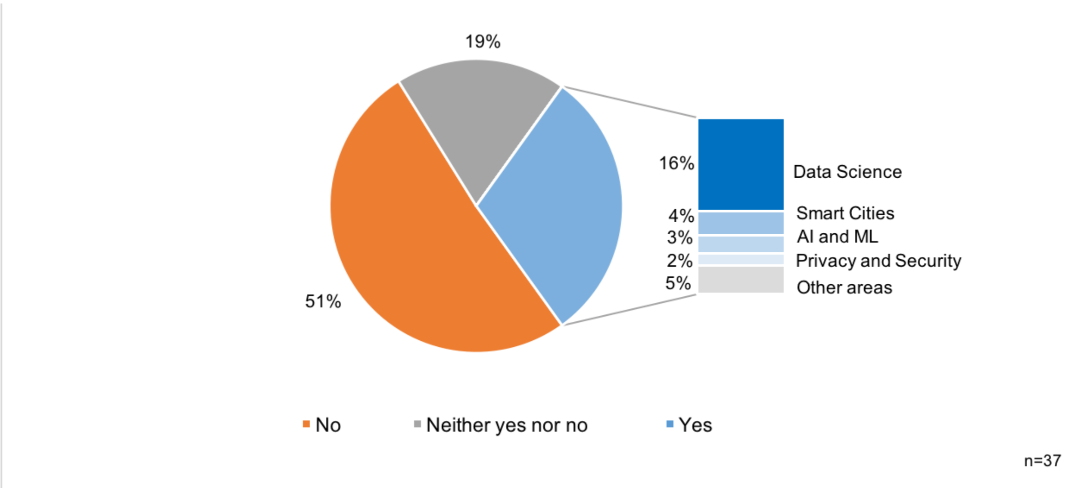



FIGURE 4. Are there interdisciplinary areas of research where your university could enter but aren't due to lack of university support?

2.3. **University support.** However, just over half (51%) of the respondents recorded (see Figure 4) that their university supported all areas of interdisciplinary research which required support. Others (30%) mentioned a variety of potential informatics areas where university support for interdisciplinary research was lacking. Others talked of the need for strategic planning to direct interdisciplinary efforts or of the need to focus given the wide range of potential opportunities.

2.4. **Additional support.** When asked about external support for interdisciplinary research directed towards their university (see Figure 5), 50% of the respondents responded

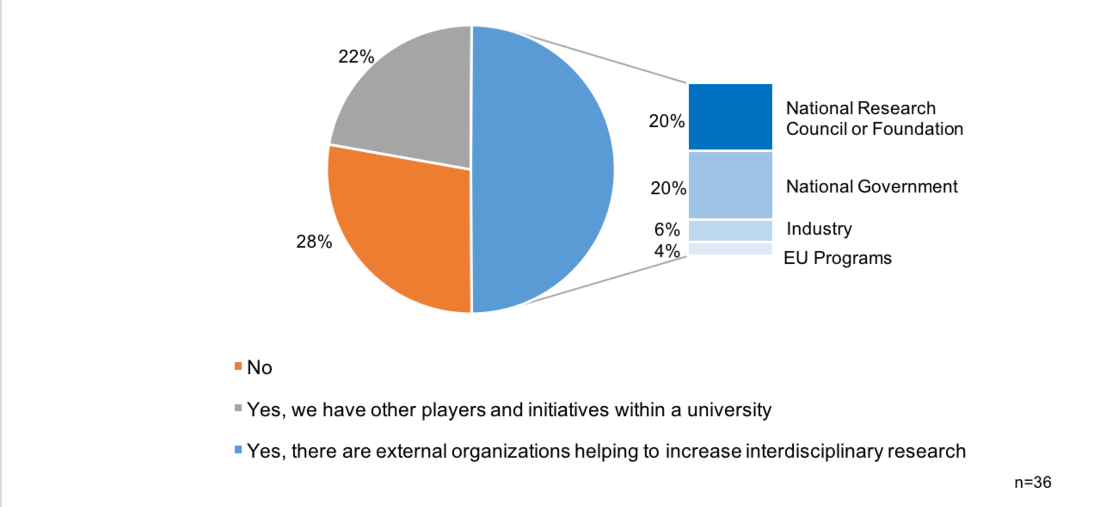



FIGURE 5. Are there other players who have helped increase the interdisciplinary research in your university?

positively with 40% stating that national public funding sources had helped to increase interdisciplinary research. A further 22% mainly discussed specific formal or informal arrangements between their department and others in their institution.

2.5. **Final thoughts.** Respondents were asked to make some more general comments. Not all respondents were especially supportive of interdisciplinary research per se. It was noted that, because some funding streams demand interdisciplinarity, it is possible that 'artificial collaborations' were formed that attracted the funds but did not make good use of the capabilities of the researchers. Frequently interdisciplinary projects are focussed on how information technology can serve the other discipline so the progress made and any breakthroughs that occur advance the other discipline but have no impact on the development of Informatics. One respondent suggested that the excitement and interest in supporting interdisciplinary projects could make it likely that lower quality proposal were accepted (compared with single discipline ones).

Respondents with more positive attitudes towards interdisciplinary research were often nevertheless pessimistic about its development mainly owing to limited funding, low esteem compared with discipline-specific research or lack of strategic direction.

## 3. TEACHING

When teaching is run by departments it is easier to have single discipline degrees rather than joint degrees, and there is no shortage of students wanting to study Informatics as a single discipline. Nonetheless there is pressure (from perspective students, academics, industry, and sometimes university leadership) to have joint degrees. The following subsections discuss the answers obtained for each specific question.

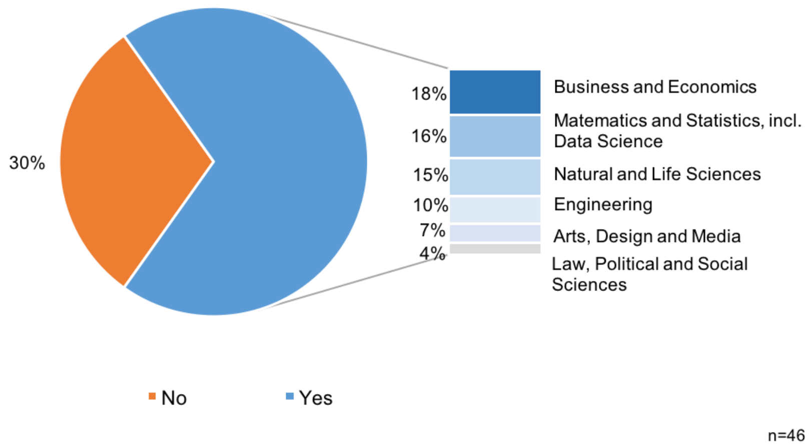



FIGURE 6. Does your university run joint degrees?

3.1. **Joint degrees.** 30% of the universities do not run a joint degree that includes Informatics (see Figure 6). Within this group of universities, some specified that all their programs entail technical aspects of IT, such as programming or data base technology. At some of these universities there are plans for some joint programmes, e.g. a Data Science BSc programme that joins CS, Maths and Industrial Engineering, and an MSc in Game Design and Production jointly with the Arts School, but these are collaborative initiatives in new directions, where the CS Department is one of the partners or the Business School has their own small Informatics programme for the new degree.

The remaining 70% of the universities run joint degrees, the most popular joint degrees including Informatics are Business and Economics (Business Informatics; CS and Business; Computing and Economics; Information systems combining Informatics and Business Administration; CS and Management; Informatics and Economics; Informatics and Finance; Economics and Business Informatics; Data Science and Entrepreneurship) followed by Mathematics and Statistics (Informatics and Mathematics; Data Science; Informatics and Applied Mathematics; Informatics and Statistics), Natural and Life Sciences (Bioinformatics; Informatics and Natural Sciences; CS and Physics; AI for Biomedicine; Precision Medicine; Geoinformatics; Chemistry and Informatics; Biology and Informatics; Informatics Health) and Engineering (Computational Engineering; Computer Engineering; Electronics and Information Engineering; Informatics and Electronics; Informatics and Telecommunications; Informatics and Cybernetics; Informatics and Mechatronics; Informatics and Aerospace Engineering; Informatics and Civil Engineering; Informatics and Industrial Engineering). Joint degrees in Informatics plus Arts, Design and Media (Technical Communication; Design Informatics; CS and communication, CS and design; ICT and media; Informatics and information science; Informatics and library science) or Law, Political and Social Sciences (Law and Informatics; Social sciences and Informatics; Data mining for political sciences; Informatics and Psychology;

Data Science and society; Cognitive Science and AI) are not very frequent at the consulted universities, they represent only the 11% of the cases. Appendix C summarizes the joint degrees (BSc. and MSc) offered by one or more universities and the countries where they are located.

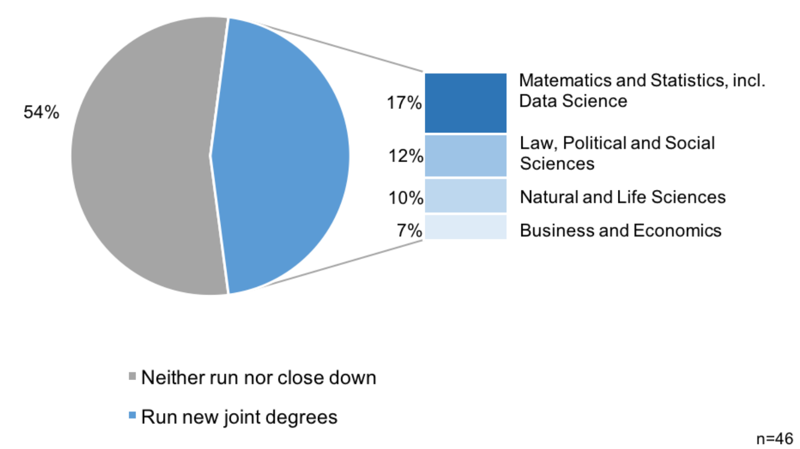



FIGURE 7. Are there plans to run new joint degrees or to close down joint degrees?

3.2. **Plans for changes in joint degrees.** In general, the situation is quite stable for those universities that are currently offering joint degrees (see Figure 7). Most of the universities not already offering joint degrees show a significative interest in running new joint degrees. The most popular joint degrees to be run in the future are in the subject of Mathematics and Statistics for which at least eight universities have shown interest, followed by the subject of Natural and Life Sciences and Law, Social and Political Sciences and finally the area of Business and Economics.

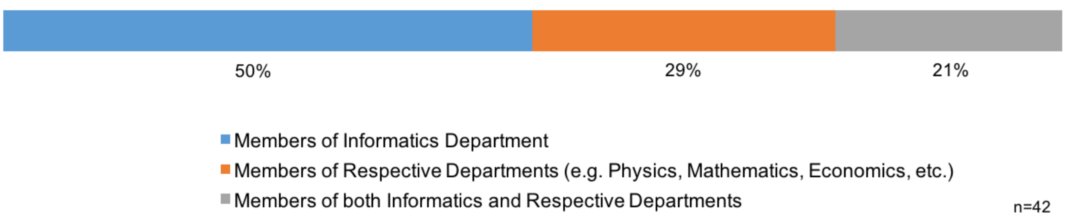



FIGURE 8. Who teaches the Informatics component of non-Informatics degrees?

3.3. **Teachers for external departments.** The results of the survey indicate that half of the universities (50%) give the responsibility of teaching informatics subjects to non-informatics degree students to members of the Informatics department (see Figure 8). In an additional 21% of the universities, the responsibility of teaching Informatics is shared among the Informatics department and other departments involved in the joint degree; some of the universities specify that only the general/basic Informatics subjects of non-Informatics degrees are taught by academics in the Informatics department (for example programming) but when the subject is related to any particular contents of the degree and the Informatics, then the subject is taught by the teachers with profile related with the specific degree. For example, the Bioinformatics of the Biotechnology degree is taught by Chemists. In other universities, Informatics component of non-informatics degree programmes is sometimes taught by the Informatics department, especially the more advanced levels. Some of the Informatics departments have not enough human resources to acquire teaching responsibilities for non-Informatics degrees . A significative percentage of the universities consulted (29%) recognize that Informatics components of joint degrees are taught by other departments such as Physics, Mathematics, Economics, etc., depending on the subject of the joint degree.

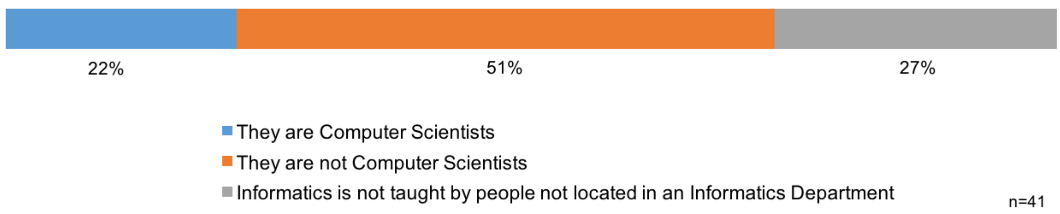



FIGURE 9. What training do teachers of Informatics outside of the Informatics department have?

3.4. **Training of Informatics teachers outside of an Informatics department.** 27% of the respondents reported that all Informatics taught in their university was taught by members of the Informatics department (see Figure 9). Additionally, 22% of the answers specify that Informatics is taught by Computer Scientists. Most of the universities participating in the survey recognize that some of the people who teach Informatics for students of non-informatics degree do not have a background in Computer Science (51%). Usually, when the Informatics subjects are taught by non Computer Scientists, the teachers have a background formation in the same degree the students are following; e.g. electrical engineers in the Electrical Engineering Schools, Economics/Management people at the Business School, Physicists or Engineers in Robotics or Industrial Engineering degrees. Additionally, in some universities the basic Informatics courses are taught by non Computer Scientists.

3.5. **Final thoughts.** The range of the answers is really broad. For some universities there exists a clear discipline-responsibility, but in others there are no clear policy about which department teaches Informatics in non-informatics programmes; in several universities the lack of human resources prevents the Informatics departments from being in charge of teaching Informatics subjects in non-informatics degree programmes.

## 4. People

If interdisciplinary research and teaching are to thrive, in addition to a positive hiring policy there needs to be good career development for those that undertake it. In general, it is possible to affirm that the situation, even if significantly different from case to case, reveals a significant level of immaturity that will have to be overcome in the near future if interdisciplinary research and teaching are to thrive. The good news is that some universities, even if in a non-completely structured way, are investing significant effort to increase the presence of interdisciplinary faculty among research and teaching staff. More time is certainly needed to assess the effects of these investments and to see a change in the most conservative countries in Europe. The following subsections discuss the answers obtained for each specific question.

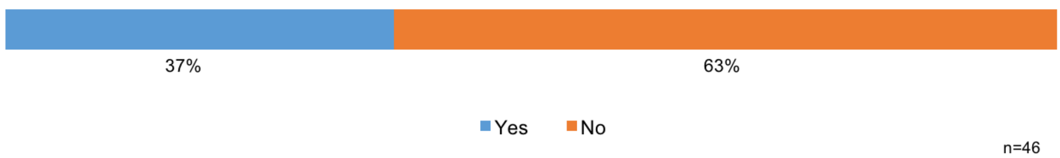



FIGURE 10. Does your university explicitly hire academics who focus on interdisciplinary research?

### 4.1. **Interdisciplinary hiring.**

63% of the respondents have affirmed that their university does not explicitly hire interdisciplinary researchers (see Figure 10). In Italy this is due to the organization of research areas in distinct *scientific sectors*, which are mostly related to a single discipline and cannot be easily revised to follow the advances of research and technology. Spain appears to show similar problems.

Among the 37% of positive respondents, some identify bioinformatics as one of the areas where multidisciplinary researchers are hired. Other identified areas concern man-machine interaction, medical informatics, AI/data science, and media informatics/game design.

### 4.2. **Affiliation of interdisciplinary faculties.**

In 74% of the cases, multidisciplinary researchers are rooted within a department (see Figure 11). According to the comments associated to this question, this seems to be due to the need to assign every faculty to a specific department. The respondents, however, note that such researchers spend also part of their time in a multidisciplinary centre or in another department.

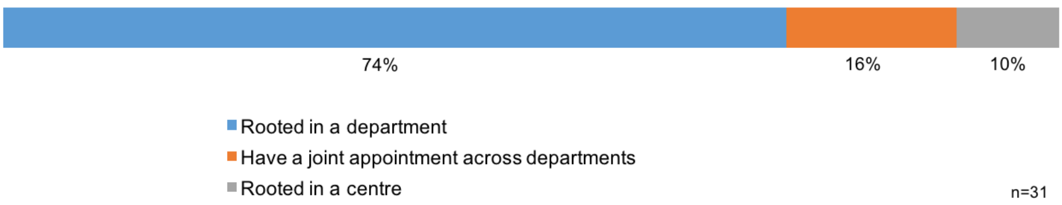



Figure 11. Are faculty rooted in a department, have a joint appointment across departments, or rooted in a centre?

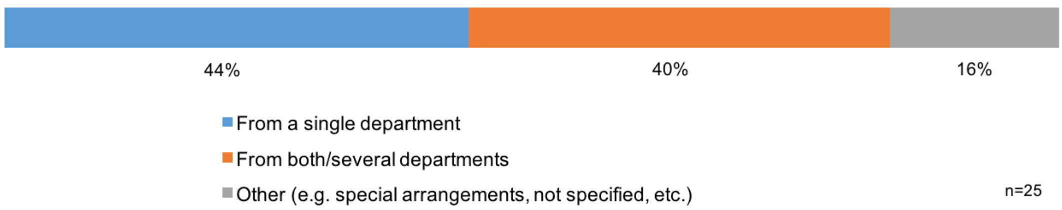



Figure 12. How is their quality judged for both appointment and for promotion?

4.3. **Assessment of interdisciplinary faculties.** As shown in Figure 12, there is an equal distribution between universities where the appointment/promotion assessment is performed at the department level and universities where this happens across departments. Analysing the specific comments by the respondents, it is difficult to find common patterns as the mechanisms for appointing and promoting faculties appear to vary significantly from country to country.

4.4. **Planned initiatives concerning multidisciplinary hirings.** As shown in Figure 13, the answer to this question appear to be quite similar to the ones discussed in Section 4.1. Also in this case, 63%of respondents do not see any plan to hire multidisciplinary researchers while among those who see these plans in place natural life and science and, in particular, bioinformatics, appear to be the most targeted field.

4.5. **Final thoughts.** The answers to this question show that the situation is still quite immature. In the cases where universities are largely autonomous from national agencies, hiring interdisciplinary researchers is encouraged when there is some funding, often by third parties, dedicated to this. Even in this case, respondents highlight the difficulty of comparing researchers with different background and skills and the current lack of complete understanding of the phenomenon given the limited number of multidisciplinary researchers that are currently in the system.

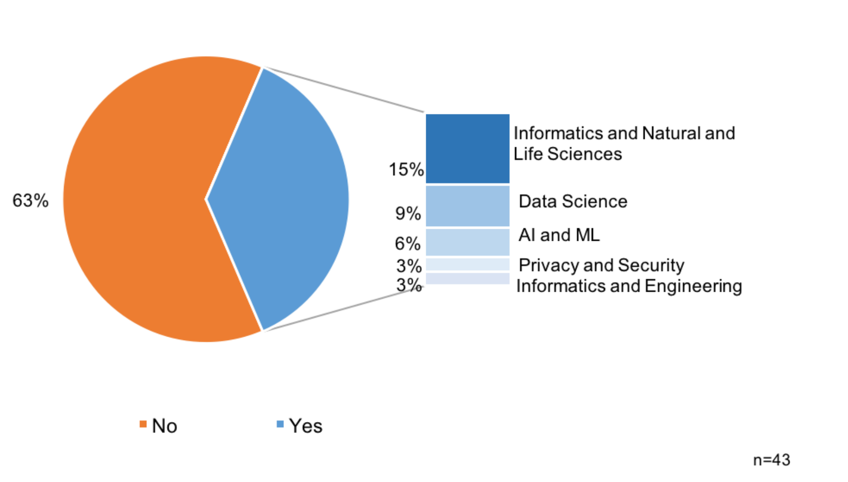



FIGURE 13. Are there any initiatives planned to hire in interdisciplinary areas?

Respondents from countries where the hiring system is strongly regulated by some national agency, highlight the difficulty to introduce some flexibility and to define long-term plans which include multidisciplinarity as an important aspect.

## 5. Data Science

The progressing digitalisation of all aspects of human activities has tremendously increased the available data and their complexity with respect to volume, veracity, velocity, and variety. Terms like big and smart data have been coined to point towards a fourth way of scientific knowledge generation. Following experimental sciences, theoretical sciences and computational sciences, the rather new field of Data Science has been rapidly emerging in recent years. Data science extracts knowledge from data in a generalisable way. It explores, abstracts, and communicates intricate systems through simplified models derived from data. Based on large and rapidly growing data repositories, Artificial Intelligence, machine and deep learning, with subareas like convolutional neural networks (CNNs), have exploded in scientific research and public attention. The academic educational system is only beginning to adjust their curricula to the appertaining challenges. A rapid increase in the analytics and Data Science job market is predicted, where the data scientists will have to master a very diverse skill set. Examples include the use of programmable tools to prepare and preprocess the data, generating engaging visualisations, estimating the confidence of the generated results, and automating the analysis process to increase repeatability. Learning Data Science involves very many miscellaneous fields like: mathematical and computer science foundations, statistics, programming, artificial intelligence and machine learning, text mining with natural language processing, visualisation, big and smart data mining and management, data ingestion and wrangling, applying and integrated use of various toolboxes. Informatics is a key basis and enabling technology in many of these subareas. The rapid evolution of the field of Data Science and its inherent very large diversity concerning technological approaches and application areas, make the specification, shaping, and localisation of Data Science curricula especially challenging. The following subsections discuss the answers obtained for each specific question.

5.1. **Data Science's Home Department.** Data Science is located in about 46% of cases at the Informatics departments (see Figure 14). In 30% of the cases Data Science is jointly handled by the Informatics and Mathematics/Statistics departments. Even more than two departments are jointly organising Data Science activities in 13% of the cases. Only in 7% of the cases a single department other than Informatics (e.g., Statistics, Economics, Mathematics) is the main responsible unit. This distribution indicates the central role of Informatics in the developing field of Data Science. Data science is happening in almost all disciplines, but the highest concentration of expertise and courses seem to be in the Informatics and Statistics departments. Sometimes Data Science and Artificial Intelligence are seen as cross-sectional disciplines, which are governed by groups of interested departments (from mathematics and logic to sociology and philosophy). The economic and business departments were also mentioned several times as participating together with Informatics and mathematics in Data Science activities. Examples of other single department set-ups have been given, like Bio-nano Sciences, Economics Studies, and Statistics.

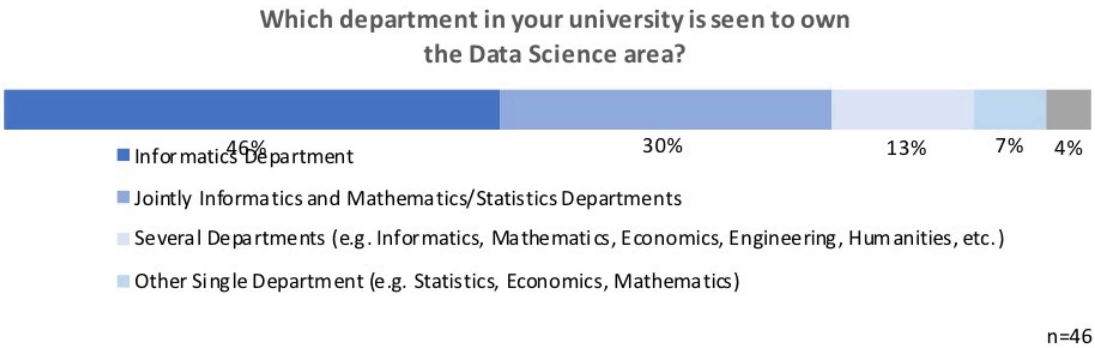



FIGURE 14. Data science is part of what discipline?

5.2. **Perception of Informatics.** A large majority of 61% of respondents indicated that the rise of Data Science has changed the perception of Informatics in the respective university (see Figure 15). Ethics and other social science aspects are considered to be increasing in relevance. There are initiatives to develop introductory courses on digital literacy and skills in all study programs. The importance of information technology is considered to be increasing beyond computational thinking to cover topics like Data Science and Machine Learning. Informatics is considered to be the main knowledge centre in the digital transformation of society and many initiatives are under way that are changing how Informatics is perceived. A growing number of non-informatics departments are asking Informatics departments to teach Data Science courses. Also, a tendency towards interdisciplinary curricula is observable (like a bridge to Statistics and Economics). At many places Informatics is recognised as an integrated part of the transformative processes currently underway. The increased relevance of Informatics is reflected in higher funding and a surge of interest in Data Science studies by potential (Informatics) students.

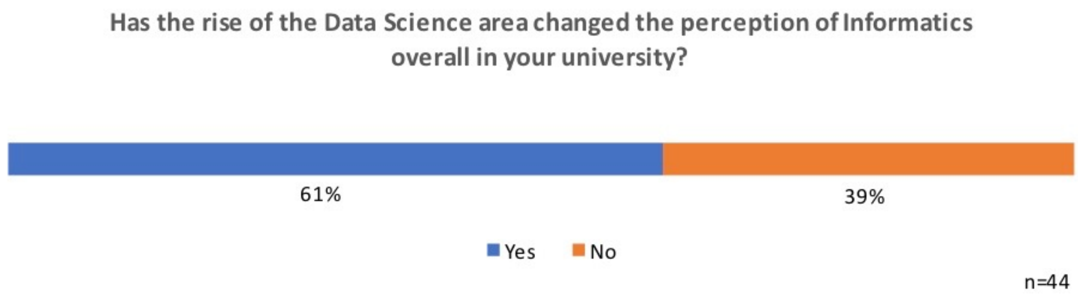



Figure 15. Has the perception of Informatics changed with the rise of Data Science?

5.3. **Current Arrangements at Universities.** The initiative on digital skills programs coming from the top university level beyond the Informatics department might be positive in supporting implementation acceptance. At most places the university upper levels consider the scientific and societal impact of Data Science and Artificial Intelligence rather in the (external) application domains, although an increase in Informatics students is recognisable. The early awareness of Data Science and Machine Learning as areas of rapidly increasing importance is considered crucial. Due to inertial forces (especially at larger universities), however, sometimes active strategies from the top university level is lagging, though bottom up approaches might compensate for this. As in analogous situations in the past, Informatics is struggling to be viewed only as a service department to help other domains in solving their Data Science problems. This is similar to previous interdisciplinary approaches (e.g., multimedia, computer graphics, animation) where Informatics is used as a tool, but gradually also as a research partner on an equal footing. The surge in interest in Data Science is accompanied by larger resource flows. The uncertainty about where to locate the Data Science activities might lead to the simultaneous development of several research groups at one university. This decentralised approach might allow the different departments to grow and manage their own Data Science groups with discriminative strengths. The quickly amplified interest in Data Science is primarily considered an opportunity, where it is challenging to follow and sustain all parallel activities. Currently the interest in Data Science, Machine Learning, and Artificial Intelligence is so large that this might overshadow all other areas of computer Informatics. Too imbalanced funding opportunities and student flows should be avoided to provide a well-adjusted portfolio of competences to the society and economy.

5.4. **Final Thoughts.** The interest and popularity of Data Science and Artificial Intelligence has dramatically risen in the last 10-20 years. These technologies have the potential to be driving and enabling technologies for the rapidly unfolding digital transformation of society. The very fast developments lead to many daunting challenges, e.g., concerning privacy, security, bias, reliability, robustness, legal and ethical implications. It is not yet clear where Data Science should be anchored, e.g., in the Informatics department, multi-department units, application domains, also. Due to the developmental speed, established organisations like universities are struggling to swiftly adjust their organisational structures and educational portfolios, where long term changes have yet to be implemented. For some experts in potential applications fields Data Science and Artificial Intelligence might be perceived as a hype that will cool down eventually. Despite this, most experts see the pervasive utility of informatics tools for their research area. The data scientist as a profession will be much more heterogeneous in the required skill set as compared to other interdisciplinary approaches, like Business Informatics, Bio-Informatics, or Medical Informatics, which basically involve two disciplines each. Considering the wide array of concerned fields, the data scientist will have a deep knowledge in just one or a few specialties and have a broad (and shallow) knowledge of the many other concerned areas. Data science encompasses a mixture of multidisciplinary skills ranging from mathematics/statistics, programming/databases, domain knowledge/soft skills, communication and visualisation. The fluidity of the development and the breadth of the area will transfer to Data Science groups, centres, and curricula with largely varying specialisations. It seems very likely that Informatics will play a key role in all these developments, where we should pro-actively use the many emerging opportunities.

## 6. STRUCTURE

Creating actual rather than virtual interdisciplinary centres is likely to improve the chances of interdisciplinary research and teaching lasting. The following subsections discuss the answers obtained for each specific question.

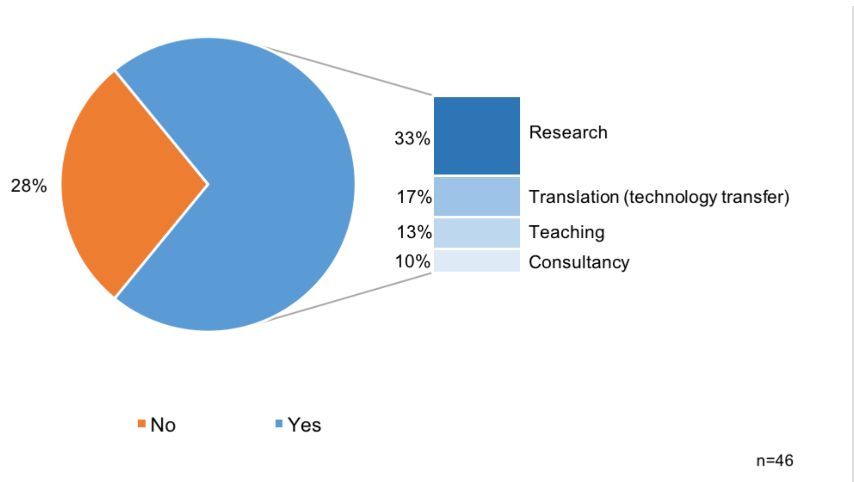



FIGURE 16. What are the interdisciplinary centres?

6.1. **Interdisciplinary centres.** 28% of respondents say their university does not have real interdisciplinary centres (see Figure 16). Of those who commented on why the lack of centres only one actually replied that their management was averse to setting up additional administrative structures. The rest just said there were informal groupings, but nothing officially supported. 46% of all of the interdisciplinary centres are set up primarily for research and only 18% for teaching. The rest are primarily involved with industry.

There are a broad range of centres in the different universities – clearly what expertise is in a university and what the structure of the different departments/schools/faculties impacts which centres are set up in addition to the existing primary structures. The most common centres mentioned with a significant Informatics component are in Computational Science, Data Science, Life Science, Digital Society, Energy, and Security. There were also more than one university with the following centres: Biomedical Engineering, Environment/Climate, Medical Imaging, and Complex Systems. There are a wide range of centres which only mentioned at one university: Health, FinTech, Digital Humanities, Robotic Surgery, Cognitive Ageing, Bioinformatics, and Geoinformatics,

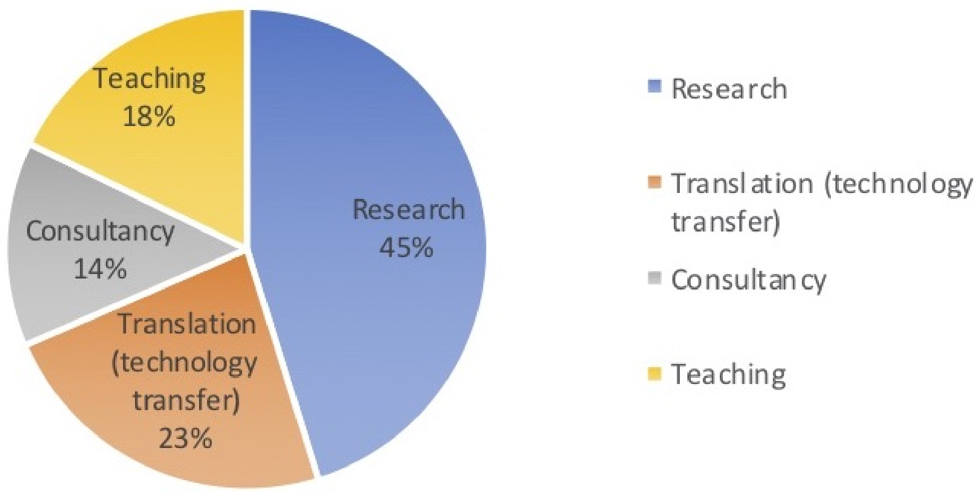



FIGURE 17. Why were the centres created?

6.2. **Purpose of interdisiciplinary centres.** 45% of all of the interdisciplinary centres are set up primarily for research and only 18% for teaching (see Figure 17). The rest are primarily involved with industry collaboration or consultancy.

6.3. **Ownership of interdisciplinary centres.** Of the 36 respondents, 21 (or 58%) are independent entities within their university, 12 (or 1/3) are co-owned by the departments that are involved and the rest have a single department that owns them (see Figure 18).

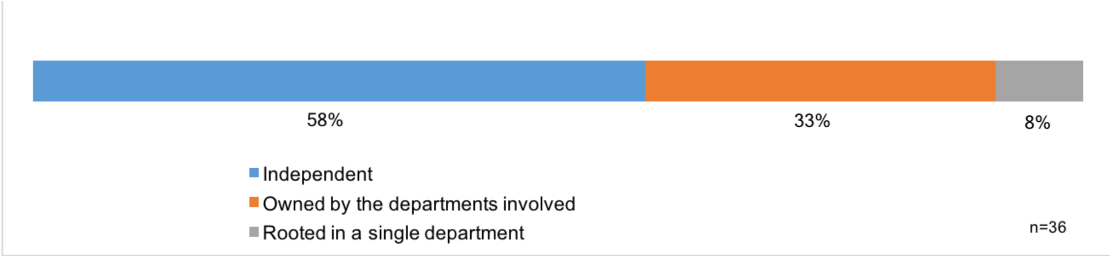



FIGURE 18. Which entity control the interdisciplinary centres?

It is surprising that so many are separate entities as this means if they are not self-funding money will be an issue.

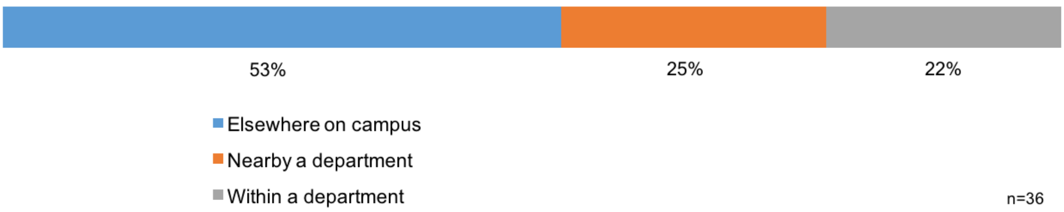



FIGURE 19. Where are the centres located?

6.4. **Location of interdisciplinary centres.** More than half of the respondents report that the centres they are reporting on are located 'elsewhere' on campus (see Figure 19). although a significant minority described the centres as 'virtual' implying that they actually had no physical location. One contributor distinguished between a large centre that had its own space, and smaller ones that were embedded in departments. Others spoke of large buildings that accommodated many different groups such that a nearby centre may not be associated with a department.

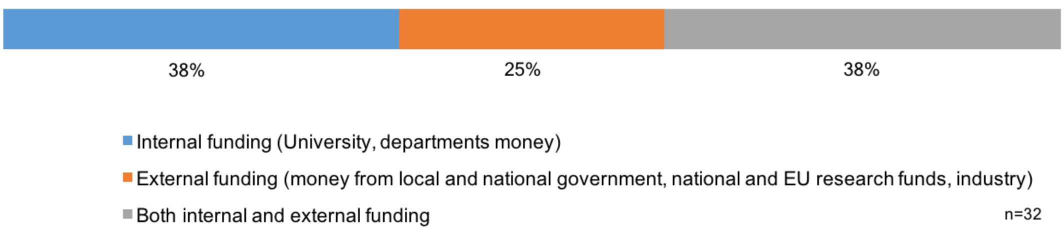



FIGURE 20. Who funds interdisciplinary centres?

6.5. **Funding of interdisciplinary centres.** Only 25% of the interdisciplinary centres reported on are funded entirely externally, the funding of the rest being equally split between entirely internal and mixed sources of funding (see Figure 20). In the majority of cases where funding is entirely internal, the bulk of the actual cash seems to come from central funds with departments providing resources 'in kind'. Frequently, time-limits are expressed (five and six years are mentioned) after which the centre is expected to be self-financing. For the universities that reported on (entirely or partially) external funding, in many cases only government and EU programmes were explicitly cited as sources of funds.

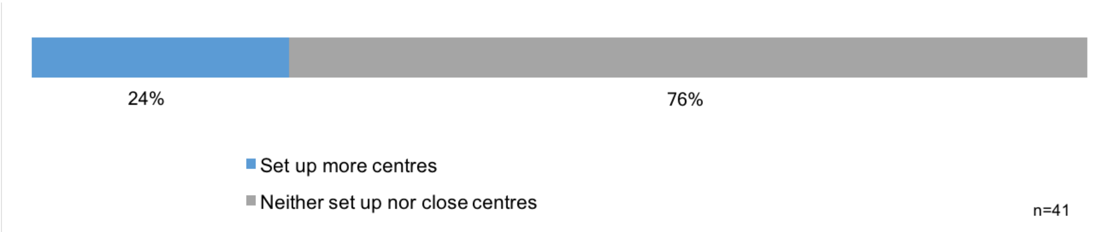



FIGURE 21. Are there changes planned for setting up or closing centres?

6.6. **Planning for changing interdisciplinary centres.** A quarter of respondents report on plans to set up new centres (see Figure 21). Some describe a notion of continuous evolution of interdisciplinary work. Only AI was explicitly mentioned as a target for the development of new centres. Other respondents, although not explicitly planning a new centre, mention the issue of the periodic review of existing centres citing various options including merging centres and/or creating new centres.

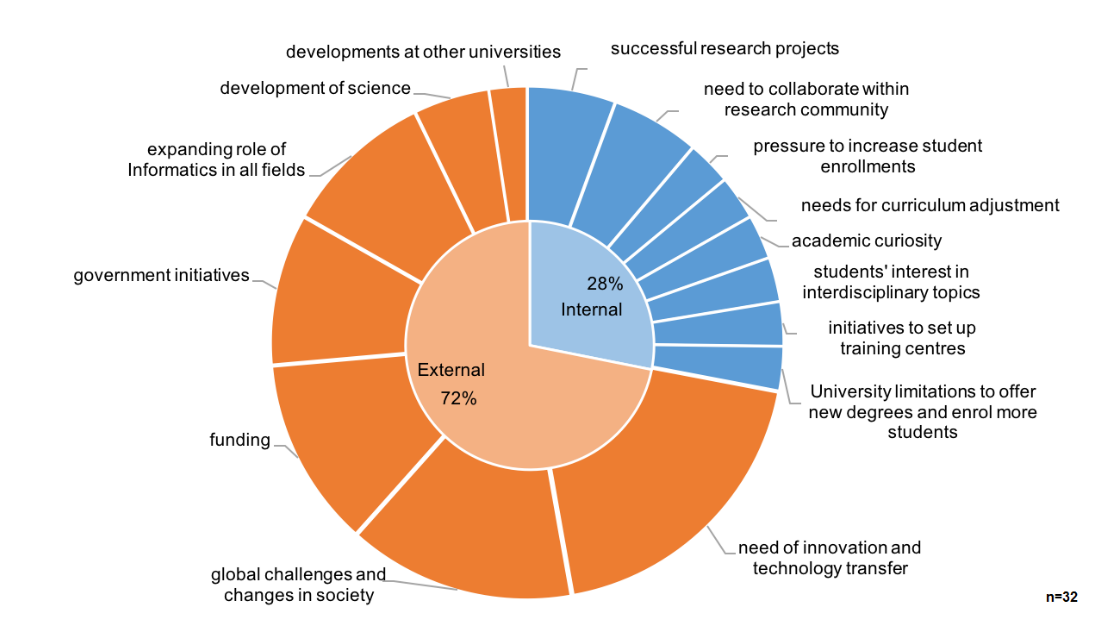



FIGURE 22. What are the drivers for new centres?

6.7. **Drivers for new activities.** Nearly one third of respondents reported on internal drivers and pressures bearing on innovative activity (see Figure 22). Amongst the drivers, academic curiosity of staff and students was cited alongside a need for research collaboration. Pressures included demands to increase students enrolment, to modify the curriculum and university initiatives to set up a centre. One university also mentioned limitations of student numbers and limitations on joint degrees that inhibited their development goals.

The other respondents addressed external drivers and pressures. The most significant cited pressure concerned the societal influence of globalisation together with an associated driver on universities to promote innovation and technology transfer (47%). The next most significant pressure is the search for funding driven by government initiatives (30%) whilst other respondents observed the expanding role of Informatics in other disciplines and the pressure on Informatics departments to support these disciplines (20%). Finally, one respondent mentioned competition between universities as an external pressure.

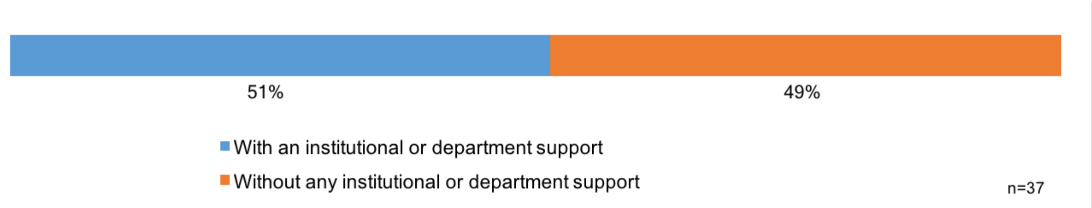



FIGURE 23. How much support is provided for interdisciplinary work?

6.8. **Support for interdisciplinary work.** Respondents were evenly split over this question (see Figure 23) although several of those who claimed institutional support were rather equivocal - "I would guess so" and "Some departments ...". Respondents who reported no institutional support divided into those who stipulated some form of external support and those who did it "as a hobby" ( 25%).

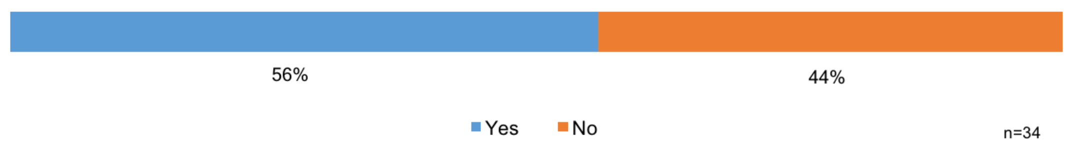



FIGURE 24. Interdisciplinary hirings

6.9. **Strategic vision.** More than half of the respondents reported on centres created from strategic initiatives (see Figure 24). Many of these were oriented towards Informatics themes (FinTech, Crypto-currencies, Data Science) but several other types of centre were mentioned (Learning and Education, Cultural Heritage, Sustainability and Energy).

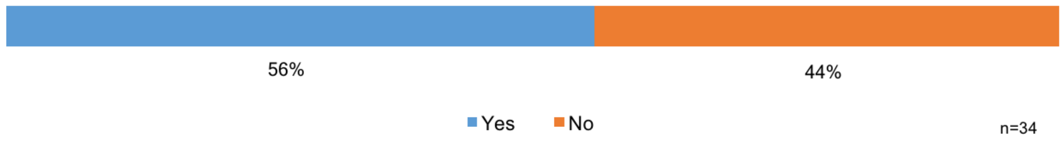



Figure 25. Is there an official strategy to widen the role of Informatics?

6.10. **Official strategic vision.** Respondents were exactly split on this question (see Figure 25). Of those who answered positively, the emphasis was on multidisciplinarity for about half the respondents. Informatics topics cited by others included Cyber Security, Data-driven Innovation, Intelligent Systems, Applied Computer Science and Digital Humanities. Respondents who answered "No" were not very forthcoming with their comments.

6.11. **Final thoughts.** Nineteen respondents contributed their overall views on the current situation in their universities. One response was wholeheartedly supportive citing good funding, strong collaboration and a sound international reputation as attractive to world-class researchers. Other commentators mentioned limited or non-existent funding and other, higher priorities (like increased student enrolment) as factors which retarded interdisciplinary initiatives. Two universities thought that Informatics was too junior a partner in the context of their university to make much impact.

By far the most significant issue concerned the nature of either the central or departmental strategic direction. Three respondents asked for greater freedom for individual researchers to be more creative with ideas, contacts and funding. However, there were ten contributors who asked for better communication between faculties, more structured research management or further internationalisation. A few just wanted more substance to the strategy - "It is only a goal without supporting instruments. "; "Still under construction - too early to conclude . . . ".

## 7. Conclusions

Despite the ubiquity of Informatics, in any area we examined there were a significant minority of surveyed universities that have not really engaged with interdisciplinarity. This does not preclude individual academics within these universities working on multidiscipline research and teaching. On the other-hand there are Informatics academics who are concerned that the pressure towards multi-disciplinary research is at the cost of core Informatics research. How much a university's leadership want to encourage interdisciplinarity can be seen in its policies and financial support for staff and centres. The range is very large from no policy or financial support to using significant resources for hiring staff and setting up and funding centres. The most commonly found centres are in Data Science and this is an arena which is largely seen to arise from Informatics and Statistics. It seems quite early to see a pattern on how universities are going to develop with respect to interdisciplinary research. As to joint teaching there are a very wide range of courses offered that include Informatics.

## Appendix A. Survey: The Wide Role of Informatics at Universities

(1) Research
  (a) When compared with single disciplinary research, does your university encourage or discourage (or neither) interdisciplinary research? If so how? (e.g. funding, time, physical centres)
    - Encourage
    - Discourage
    - Neither encourage nor discourage
  (b) Does your Informatics department encourage or discourage (or neither) interdisciplinary research? If so how?
    - Encourage
    - Discourage
    - Neither encourage nor discourage
  (c) Are there interdisciplinary areas of research where your university could (should) enter but aren't due to lack of university support? If so what are they?
  (d) Are there other players who have helped increase the interdisciplinary research in your university? For example has a funding body focused a programme on interdisciplinary PhD studentships which academics applied for?If so what external organisations and what programmes have increased interdisciplinary research at your university?
  (e) Please comment on any advantages or disadvantages you perceive of your university's arrangements.

(2) Teaching
  (a) Does your university run joint degrees (e.g. X and Informatics, Informatics and X, X with Informatics, Informatics with X). If yes, what are they?
    - Yes
    - No
  (b) Are there plans to run new joint degrees or to close down joint degrees? If yes what are they?
    - Run new joint degrees
    - Close down joint degrees
    - Neither run nor close down

(c) Who teaches the Informatics component of non-Informatics degrees? For example, is programming taught to Physicists by members of the Physics department, of the Informatics department or is there a servicing organisation within your university that teaches Physics students to code (or some other mechanism)?

(d) If Informatics is taught by people not located in an Informatics department are they Computer Scientists by training or research?

- They are Computer Scientists
- They are not Computer Scientists
- Informatics is not taught by people not located in an Informatics department

(e) Please comment on any advantages or disadvantages you perceive of your university?s arrangements.

(3) People

(a) Does your university explicitly advertise/hire academics who focus on interdisciplinary research?

- Yes
- No

(b) Are they rooted in a department, have a joint appointment across departments, or rooted in a centre?

- Rooted in a department
- Have a joint appointment across departments
- Rooted in a centre

(c) How is their quality judged for both appointment and for promotion?For example are they judged according to the criteria of one of the departments or both? Are the people who judge from a single department or both?

(d) Are there any initiatives planned to hire in interdisciplinary areas?

- Yes
- No

(e) Please comment on any advantages or disadvantages you perceive of your university?s arrangements.

(4) Data Science

(a) Which department in your university is seen to own this area? Is it Informatics, Statistics, jointly or somewhere else?

- Informatics Department

- Statistics Department
- Jointly Informatics and Statistics Department
- Somewhere else (please specify)

(b) Has the rise of this area changed the perception of Informatics overall in your university?

- Yes
- No

(c) Please comment on any advantages or disadvantages you perceive of your university?s arrangements.

(5) Structure

(a) Does your university set up centres for interdisciplinary work? If yes can you say which they are?

- Yes
- No

(b) Are they for research, translation (technology transfer), consultancy, and/or teaching?

- Research
- Translation (technology transfer)
- Consultancy
- Teaching

(c) Are they rooted in a single department (say which one), owned by the departments involved or independent?

- Rooted in a single department
- Owned by the departments involved
- Independent

(d) Are they physically located within a department, nearby or elsewhere on campus?

- Within a department
- Nearby a department
- Elsewhere on campus

(e) How are any centres funded? Does the university provide any money to startup or are they funded by external money? Does the university provide longer term money?

(f) Are there plans to set up more centres or to close centres? If so what will they be?

- Set up more centres
- Close centres
- Neither set up nor close

(g) What are the drivers or pressures (both internal to the department/ school/faculty/university and external to the university) that you see on the horizon that may lead to new activity?

(h) Is substantial interdisciplinary work undertaken by academics without any institutional or department support?

- Without any institutional or department support
- With an institutional or department support

(i) Are there any centres for interdisciplinary work that have been set up due to a strategic decision by the university or department/school/faculty rather than as supporting activities of existing faculty? If so which centres?

(j) Does your university have something in their official strategy to widen the role of Informatics or to encourage interdisciplinary research? If so what is it?

(k) Please comment on any advantages or disadvantages you perceive of your university?s arrangements.

(l) Is there anything we have missed in the survey that you wish to tell us?

## Appendix B. The participants

| | **Country** | **University** |
|---|---|---|
| 1. | Austria | TU Wien |
| 2. | Belgium | Université Catholique de Louvain |
| 3. | Bulgaria | Sofia University St. Kliment Ohridski |
| 4. | Czech Republic | Masaryk University |
| 5. | Denmark | Aalborg University<br>IT University of Copenhagen<br>University of Southern Denmark |
| 6. | Estonia | Tartu University |
| 7. | Finland | Aalto University |
| 8. | Germany | RWTH Aachen<br>Humboldt-Universität zu Berlin<br>Paderborn University<br>University of Stuttgart |
| 9. | Hungary | Eötvös Loránd University |
| 10. | Ireland | Technological University Dublin |
| 11. | Italy | University of Bari Aldo Moro<br>Università di Torino<br>Alma Mater Studiorum - Universit di Bologna<br>*Università degli Studi di Milano<br>Politecnico di Milano<br>Università Roma Tre<br>Università degli Studi di Milano-Bicocca<br>*Università degli Studi "G. d' Annunzio" Chieti Pescara |
| 12. | Latvia | University of Latvia<br>Transport and Telecommunication University |
| 13. | Netherlands | Delft University of Technology<br>*Tilburg University<br>Utrecht University |
| 14. | Portugal | Universidade Nova de Lisboa |
| 15. | Romania | Babes-Bolyai Univ. Cluj-Napoca |
| 16. | Spain | *University of Almeria<br>Universitat Politecnica de Catalunya<br>*University of Extremadura<br>*University Jaume I<br>*University of Málaga<br>*Complutense University of Madrid<br>*University Oviedo<br>*Universidad de Valladolid |
| 17. | Sweden | Chalmers — Gothenburg University |
| 18. | Switzerland | University of Bern<br>EPFL<br>University of Lugano<br>ETH Zürich<br>University of Zürich |
| 19. | UK | Cambridge University<br>University of Edinburgh<br>Imperial College London<br>University of Oxford |

## Appendix C. Joint Degrees by Country

| **Level** | **Joint title** | **Countries** |
|---|---|---|
| BSc | Economy and Computer Science | Spain, Switzerland |
| BSc | Economics and Business Informatics | Italy, Switzerland |
| BSc | Business Informatics | Austria, Czech, Germany<br>Italy, Switzerland, UK, Denmark |
| BSc | Informatics and Management | Italy, UK |
| BSc | bioinformatics, | Czech, Denmark, Italy, Switzerland |
| BSc | Geoinformatics | Italy |
| BSc | Informatics and Mathematics | Netherlands, Spain, UK |
| BSc | Informatics and Statistics | Spain |
| BSc | Informatics and Physics | Spain, UK |
| BSc | Law and Informatics | Czech |
| BSc | Social sciences and Informatics | Czech |
| BSc | Technical Communication | Germany, Denmark |
| BSc | Computational Engineering | Germany |
| BSc | Cybernetic | Germany |
| BSc | Mechatronic | Germany |
| BSc | INFOTech | Germany |
| BSc | Information Science /Library science | Germany |
| BSc | Data Science | Italy, Spain |
| BSc | ICT and Media | Italy |
| BSc | Data Science and Entrepreneurship | Netherlands |
| BSc | Data Science and Society | Netherlands |
| BSc | Cognitive Science and Art. Intellig. | Netherlands |
| BSc | Informatics Health | Spain |
| BSc | Informatics and Engineering | Spain, UK |
| MSc | Data mining with political Sc. | Italy |
| MSc | Informatics and Psychology | Italy |
| MSc | Comput. Sc. and Engineering | Switzerland |
| MSc | Bioinformatics | Switzerland |
| MSc | Design Informatics | UK, Denmark |