

Unit-level environment template (REF5b)

Institution: Goldsmiths, University of London
Unit of Assessment: 11, Computer Science and Informatics
1. Unit context and structure, research and impact strategy

Context

Over the last two decades, Goldsmiths' Computing has been developing with the express purpose of contributing to the College's core strengths in creative practice and studies of social engagement. This has led us to become a Department with a dedication to inter-disciplinary research, working with other Goldsmiths' Departments and other institutions to develop projects, research centres and groupings around computationally informed creative practice and around data-analytic social science. This trajectory leads to research outputs that are unusual for a Computer Science Department: our research finds expression in, and inspiration from, artistic expression, creation and performance. In this period, we performed computational musical pieces at the Barbican; produced AI-based computational instruments used in AI jazz improvised performances on Radio 3; displayed computational art works at the Centre Pompidou, and the Hermitage; and produced commissioned public art works displayed in Trafalgar Square, and in public squares across Asia and in Chicago. These events form part of our research culture and contribution, and they are also part of our impact strategy, encouraging non-computing audiences to engage with computing ideas.

In this REF period, the research focus of Goldsmiths' Computing broadened, with its inter-disciplinary activities reaching beyond arts and social sciences to other sciences, mathematics, and finance. This expansion of view is partially driven by the growth of Goldsmiths' School of Professional Studies, Sciences and Technology (PSST), where Computing sits in the College structure. Zimmer, Head of Computing, is collaborating with the Head of School, Banissy in 2020/21 in the planning of a thematic inter-disciplinary School-wide exploration of the Future of Work. This initiative encompasses research and teaching across the School, reaching from Management to Well-Being, to Computational Technology. Computing is not new to setting agendas for inter-disciplinarity at Goldsmiths. In 2016, the Warden of Goldsmiths asked d'Inverno, Professor of Computer Science and then Research Pro-Warden to create research themes to support cross-college research. Zimmer, working with d'Inverno, led a series of consultative seminars across the College. Over 150 staff members took part in the process, suggesting and elaborating a large number of suggested themes. In the end, four were chosen for development. Two of these have strong Computing components: [Invention, Creativity and Experience](#); and [Technologies, Worlds, Politics](#). The themes are not only research ideas but also have a real status with meetings involving members from several departments and budgets to support hosting research events and scoping joint inter-disciplinary research projects.

The Computing Department is proud of its central position in cross-department thinking at Goldsmiths. We are also proud of our history and reputation in exploring and furthering the relationship between creativity and computation. We believe that in this way we have contributed, over the last twenty years, to the diversity of thinking in the discipline of computer science. We are now at the beginning of an intensification and broadening of that cross-disciplinary thinking, which is leading to new disciplinary alignments. We have reached a new phase of Goldsmiths' Computing.

Structure of Research Areas

The Department's research aim is to preserve and enhance its distinctive foundations in creative computing, while taking the same interdisciplinary impetus into new areas: data science, algorithmic foundations, quantum mechanics, robotics, biomedicine, and psychology. This research is structured into four very broad research areas; the first two devoted to bolstering and sustaining the core Departmental research, and the second two, largely but not exclusively, support new areas of research. The groupings are: (1) Creativity and Computation; (2) Human/Computer Interaction; (3) Data Science; (4) Algorithmics. Each of these areas host their own seminars and events, and members publish and work on grants together. Each of the research sectors is led by a partnership of two members of staff, usually one senior and one less so.

Creativity and Computation (led by Tanaka and Crawford). Goldsmiths' Computing is unusual in that a large portion of academic staff work professionally as creative practitioners, artists and performers. This professional practice motivates and underpins much of the Department's research. The combination of arts and science practice is tightly interwoven: in the research we do ourselves and in teams, in our support of a larger research community, and in the way we present our research to the public. A pair of events sponsored by the Arts Council, Creative Machines 1 and 2, are exemplars both of how we support interdisciplinary research across institutions and how we provide a public face to our research. These events, exploring human/machine creativity in contemporary art, consisted of exhibitions and workshops. They highlighted works by computer scientists and artists linked to Goldsmiths and to the CYLAND MediaArtLab in St. Petersburg, Russia. The events relied on and stimulated work across institutions and across disciplines. The exhibitions were open to a general audience. This is one of many examples of exhibitions involving art produced by or with Goldsmiths' Computing: others include the Centre Pompidou, the Lowry Centre and the Hermitage. There have also been many musical performances based on this research including concerts at the Barbican and a live performance on Radio 3. And in a new cross-Department collaboration, Tanaka is working with Goldsmiths' Music and Media Departments, to innovate and host immersive public performances as part of an AHRC/EPSRC funded project. An example of the work reaching a supporting a larger community of researchers from different disciplines is Crawford's AHRC and EC supported music informatics retrieval work, in which Goldsmiths is a central hub in a large network of researchers across the UK and Europe. And, finally, Goldsmiths hosted a joint China/UK workshop in the creative industries, including academics, commercial partners and cultural institutions from both countries. This led to an AHRC/UKRI grant to stimulate interdisciplinary research projects across the two countries.

Human Computer Interaction (HCI) (led by Latham and Pan). HCI research at Goldsmiths is long established. One subgroup, *Embedded Audio-Visual Interaction* (EAVI), has a fifteen-year history of pioneering new paradigms of interfaces to computational systems. The group runs a series of internal research seminars and external talks and performances in London. EAVI enables different kinds of interactions with computers. For example, we have supported people with disabilities to express themselves musically with specially designed computational instruments. Fiebrink, funded by the Paul Hamlyn Foundation, created, in collaboration with music therapists and music teachers, a suite of prototype musical instruments for children with disabilities, with which they performed at the Barbican. While Tanaka, in work reported on US national television networks, produced a haptic interface for visually impaired audio producers that is being used in

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professional recording studios in the US and UK. The HCI group has supported the research community through running exhibitions, performances, and workshops. Fiebrink and Gillies co-chaired a workshop on Human-Centered Machine Learning at the 2016 ACM SIGCHI. The group is active in Virtual and Augmented Reality research. Latham and Leymarie's research concerns scientific visualization. Their work supports medical research and public understanding of science. Medical researchers at Oxford, York, and Imperial all report that their research benefits from the insights they get from experiencing DNA, proteins, and viruses in more intuitive ways. This research was one of twelve powerful VR applications highlighted by Forbes Online and has been shown to the public at many venues, including New Scientist Live and at a Scientific VR Workshop, hosted by The Francis Crick Institute and Goldsmiths in 2019. The group also used VR systems to make realistic, virtual humans and human-like characters. Pan, working with UCL, has used these systems to train medical professionals to deal with difficult social interactions more confidently. Pan and Gillies, supported by UKRI, are helping develop a game, based on *Peaky Blinders*, that incorporates AI-enabled realistic characters. The game is set to be realised commercially in 2021.

Data Science (led by Soldatova and Stamate). Data Science has been a feature of the Department throughout the period. In 2015 Goldsmiths partnered with the company, Tungsten, to set up a research centre based at Goldsmiths with a remit to investigate the use of AI technologies to problems in procurement analytics. The centre continued to do commercial-facing data science projects throughout the REF period in partnership with two other companies. The group has been a particular area of growth for the Department both in teaching and research. The Department is developing a suite of postgraduate programmes, both online and on-campus, around data science and its applications. The Department has appointed five established researchers to lead the development: Buchan, Soldatova, Russell-Rose, Aquino, and Nicolaou. The group interacts extensively, sharing ideas for research, especially around medical applications. Soldatova co-runs an EPSRC grant with Cambridge, set on producing AI systems that can choose cancer treatments as effectively as a human oncologist. In collaboration with Manchester, Stamate uses Data Science techniques to predict the risk of dementia through the scrutiny of primary care records. During this REF period, work of the group has been funded by the BBSRC, Horizon2020, the EPSRC, DARPA, and Alzheimer's UK. A public-facing output of this group was the [Robot Scientist](#) exhibition in the Science Museum in 2015 as part of the European-funded AdaLab project. The event attracted 3500 visitors who learned, through demos and games, about computational approaches to drug discovery.

Algorithmics, Quantum Informatics, and Financial Technology (led by Hughston and Hoban). Hughston has contributed to the fundamentals of the quantum theory of measurement and the thermodynamics of quantum systems, which is relevant to the characterisation of near-term, noisy quantum computational devices. Hoban developed a new theory for systems, going beyond quantum theory, in a paper that was awarded the 2018 Paul Ehrenfest Prize, being judged the best paper in quantum foundations in the last five years. Hoban is funded by a FQXi (Foundational Questions Institute) with a £36,691 grant to develop new causal discovery techniques for quantum systems (based on probabilistic reasoning with directed acyclic graphs). This relates to Badkobeh's work on graph and string algorithms, supported by Leverhulme and the London Mathematical Society. In the Goldsmiths spirit of interdisciplinarity, she is now working with musicologists to apply her string algorithms to questions about music informatics. The group is also applying algorithmic thinking to questions around finance. For example, Chinthapati has studied financial systems by creating agent-based models to explore the opportunities and dangers of ties

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between different players in a financial market. He is actively setting up a network of London financial institutions to work with us and our students on these questions.

Research Strategy

The overall goal for the present and next REF periods is to reinforce our core interdisciplinary strengths while adding new subjects and new techniques. We have achieved that in the present REF but the goal for the next period will be, possibly to expand further, and definitely to better integrate the thinking across strands. To achieve these goals, the Department has developed a strategy with four pillars. Goldsmiths' Computing aims to be **stable and sustainable** (strengthening our computing/creativity research values), **expansive** (open to new ideas, audiences and disciplines), **placed in the world** (making a difference to individuals, charities, companies, and universities), and **drawing from and adding to department teaching**.

Stable and sustainable. The Department is committed to helping the core research – computing in *relation to arts and creative industries* – thrive. One way is through the support for international collaborations. For example, the Department hosted two international art & technology symposia, jointly with Kyoto University. We have also encouraged and supported Tanaka in his application for another Japanese partnership: *Art, Artifice & Intelligence: A UK-Japan partnership exploring art and AI*, sponsored by the ESRC. Research in this area is also sustained by commissions and collaborations with non-university partnerships. For example, Shoben was commissioned by the Marie Curie Cancer Care charity to produce a public artwork in London's Paternoster Square commemorating the launch a fundraising campaign: 4,000 handcrafted daffodils, that responded to the environment.

Expansive. In this period, we have broadened our interdisciplinary mission to include sciences. In this submission 12% of our outputs relate to physics; 14% to psychology; 24% to biomedicine. The extent to which our researchers are making an impact in general science is evidenced by the publications in multi-disciplinary science journals in this REF submission. This research, again, is sustained by research collaborations. The Departmental research support team facilitated joint research with a US-based quantum informatics company, as well as European and UK universities. As well as broadening our topics, we are extending our audience. For example, the Department supported Latham and Leymarie, with fees and personnel, in setting up several public events, such as the Royal Society Summer Exhibition and New Scientist Live. We have also supported staff to give over 100 public lectures, including 2 TED and 4 TEDX talks and seminars at Google, Apple and Microsoft.

Placed in the world. The Department is dedicated to supporting staff to do research that improves people's lives. In this period, for example, we have partially financed a project with Great Ormond Street Hospital, using VR to train doctors to support families of terminally ill children (Pan and Gillies). We have provided staff time and administrative support for work with the charity MIND, helping sufferers of pandemic or lockdown – through the work of Ohene-Djan; to working with Microsoft Research, providing better computer access for people with disabilities (Fiebrink); and for work with the University of Manchester in diagnosis and treatment for Alzheimers' and Covid-19 (Stamate, Soldatova). Part of our strategy for keeping research relevant is to work directly with companies, particularly SMEs in the creative industries. Two projects – MIMIC, funded by the AHRC, and RAPIDMIX, funded by the EU – were set up to engage stakeholders in the process of music making with creative tools by bringing machine learning to SMEs.

Doing research that draws from and adds to our teaching. In the last two years we have launched two distance-learning programmes: an MSc in Data Science and a BSc in Computer Science. This both gave us an opportunity, and an imperative to expand our thinking, particularly in fundamental computer science and data science. That has led to our research groups in quantum computing and in data-rich, bio-medical research. It has also given us the opportunity to form a virtuous circle of doing pedagogical research based on Coursera-provided data and using the data science research techniques to analyse the data and improve the teaching.

Impact Strategy

All staff are encouraged to think about impact as part of planning their research. The Department supports staff, administratively and financially, for activities that enhance engagement and impact of their research. The specific modes of impact for Computing are set out below:

Impact on and from Arts. The Department supports staff to attend and contribute to arts exhibitions and performances. At times, as in the joint exhibition with Kyoto University, we play an active role in the organisation and running of these events. As exhibitions and performances can attract larger, more diverse, audiences than computer science ones, these events can raise questions and increase understanding of the nature of computation and creativity among audiences not usually in attendance at a computer science event. In another example, Colton's fundamental AI research on ideation was used as the genesis of what the producers called: "the first West-End Musical created by computers." The musical itself had an audience of 3,000 and it was accompanied by a platform discussion about creativity and computation and a Channel 4 SKY Arts documentary about the project (see Impact Case Study).

Public Understanding of Science. The Department produced three systems for helping scientists and lay people to better understand molecular biology by experiencing it through VR and games. The original work was done with and for medical researchers in Imperial, Oxford, and York. It has since been adapted to give non-scientists the same opportunity as professional medical researchers to experience molecular structures. The work was a central feature of the New Scientist (2016 and 2017) live events. The Department supported that event by paying exhibitor fees and providing staff including professors and students to explain the work to the public, as well as people to transport and set up the display. The Department part-paid the salary of a post-doctoral researcher for six months to make sure the engagement event could happen (see Impact Case Study)

Impact on medical practice. Pan and Gillies create virtual characters who use AI to socialise realistically. Working with UCL, they create ethically challenging scenarios to train people-facing professionals, particularly medical practitioners, to deal with socially difficult situations. They are, for example, working with Great Ormond Street Hospital on a system that helps professionals communicate sensitively with the families of ill children.

Impact on the London SME community. About ten years ago, Goldsmiths Computing set up Goldsmiths Digital Studios as an in-Department consultancy dedicated to doing projects with small companies in South-East London. Goldsmiths' Digital works on projects that build on Goldsmiths' research and employ present or recent students to work alongside an established member of staff. We have completed more than twenty such projects, mostly with SMEs in the Creative Industries.

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This supports local industry and employment. Projects in the period ranged from augmented reality for the culture sector to assistive technologies on mobile phones to visualising DNA. Falconer is on a part-time contract to run the consultancy and find and negotiate the projects.

Culture of Research Integrity

Maintaining an open research environment. The Department meets the requirements of Green Open Access through the support of staff and resources of the Goldsmiths Research Online repository. The Department supports Open Science movements and encourages staff to make their research results available to the research community and general public. Examples include Wekinator 2.0, Sound Control, InteractML, Analytics Automated, CSynth software platform, head-movements datasets at OSF platform.

Supporting a culture of research integrity. The Department has a Research Ethics Officer, who reports to the Department Research Committee and the College Research Ethics Committee. The Officer reviews and approves the research ethics proposal forms that all PhD and Masters' students must complete. Staff must submit their research ethics forms to a College-wide Research Ethics and Integrity Sub-Committee for approval. Ethical clearance must be obtained before any research project begins. Ethical considerations include the application of appropriate research protocols for projects (such as independence of researchers, no harm to human participants, integrity of research, fidelity to verifiable knowledge, consent to research and use of data, rights to privacy, confidentiality and anonymity) as well as the management of research staff.

Historical and Future Plans

In REF2014, we announced quantifiable goals for this REF period: to increase by 25% the grants won. The 60% increase in funding far exceeds the target.

In REF 2014, we announced our intention to “continue to grow our research reach and significance”, specifying the Creative Industries and Social Sciences. The former was to be built, in part, on the York/QMUL consortium; the latter was to be the result of an increased Department interest in data science. All of that happened. What was not anticipated was the turn to foundations and scientific applications. Our research strategies and the arrangements put in place have enhanced the interdisciplinarity, vitality and sustainability of the research environment.

In the coming years, we shall continue supporting interdisciplinary research, building on both the creativity research and science explorations. However, the real excitement will come from merging the thinking and techniques from the two. We do not know what forms the synthesis will take but some speculative ideas are emerging. We are planning a centre on the Future of Reality, that may bring together ideas from VR/AR and quantum informatics by, for example, using VR to help naturalise the unimaginable experience of the quantum world. Goldsmiths' Computing research already produces robots that make art and robots that discover science. Can these two be brought together? Can the scientific research on brain function be used to make artificially creative systems or interfaces that lead directly from brains to creative practice? Whatever ideas and technology we conceive, we will feed into a pan-Goldsmiths programme exploring the future of work and, more broadly, what it will mean to be human, in a world full of AI, simulated experiences, and changing habits of work, social interaction, and creativity. Whatever applications we develop will be underpinned by foundations we have laid down in this REF period: machine learning, bodily/brain

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interactions, virtual reality, quantum informatics, mathematical foundations. Building on these foundations, and merging the arts and science thinking, we will create the next phase of a truly distinctive Goldsmiths' Computing offering.

Another focus for future development is to substantially increase departmental support of ECRs and postgraduate students. The Department plans to introduce 'light' years for ECRs in which the load of teaching is alleviated to make time and resources available to boost their research profile. We shall improve our mentoring scheme, moving from an informal arrangement to more formalized assignment of mentors to ERCs. Recently, the Department has started a brownbag/seminar series that are exclusive to our postgraduate students to provide a friendly environment for knowledge exchange. We will build on its success and introduce other activities dedicated to supporting our ECRs and PhD students and enhancing our research culture.

We will also introduce activities supporting other groups of researchers, e.g. grant writing workshops for women only.

2. People

The Department is proud of its record of promoting equality and diversity and proud, too, of its record of helping staff develop their academic careers. In the REF period, we appointed 31 new academic staff members onto long-term or permanent contracts, principally staff early in their academic careers. Some staff are appointed on teaching and research and some on teaching and scholarship. We view these contract types equally. However, we are supportive of staff who want to move from one career path to the other, and we expect that at least half of the staff members who are currently not on research contracts to feature in the next REF.

Recruitment. All T&R staff are recruited with the Department research strategy in mind.

The recruitment practice supports:

(1) Stable and sustained research by reinforcing our creativity-related research in this period.

39% of the staff we appointed in the period have arts backgrounds and/or practices, many adding new dimensions to that aspect of the Department's research. For example, Pritchard is a productive exhibiting artist, who also has a background in sociological research. She uses her art and computing technology to explore, and draw attention to, environmental issues, gender issues and big data. Another new appointment, Lomas, is an Emmy Award winning graphic artist who, in this REF period, exhibited computational artwork in the Centre Pompidou. Our recruitment strategy sustained and strengthened further our arts focus by appointing: Falconer, Fasce, Forth, Grow, Lomas, Lotto, McClellan, Perry, Pritchard, Raskob, Zbyszynski, Zucconi.

(2) Expansion of research disciplines. 26% of the new appointments have backgrounds in sciences other than computing. Hoban, Hughston, Milne all work on quantum informatics. Hughston also works on financial technologies, as does Chinthapati. Aquino, Buchan and Garagnani work in computational biology. Maiolino's background is mechanical engineering, which is the basis of her work on tactile skins for robots. These eight appointments mark a fundamental expansion of the Department's research disciplines.

(3) Impactful research. The recruitment practice helps us broaden our place in the world. In the REF period, for example, we appointed Lotto, who has given three TED talks (two in this period) about perception, with a combined viewership of 10 million. We also appointed Buchan, who is developing and running the PSIPRED Workbench, an important bioinformatics machine-learning based data server that services requests from about 5,000 unique users a month.

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(4) Research that draws from and adds to department teaching. The expansion in research topics supports existing teaching content and contributes to forthcoming programmes. In particular, to underpin new programmes in Data Science and Financial Technologies, we have expanded the data science research team by appointing Soldatova as a reader; Buchan, Aquino, Nicolaou, and Gerow as lecturers; and Russell-Rose as a senior lecturer. The number of outputs submitted for these new appointments testify to the large effect they are having on our research culture.

Early-Career Researchers. About a quarter of our Category A staff are early career researchers (ECRs). Providing an effective pipeline by nurturing them is vital to our sustainable contribution to the research of the Department and the diversity of research in the discipline. New appointments are assigned mentors with relevant research interests. For many staff members, mentoring includes collectively developing group shows and performances. The Department runs workshops, principally for ECRs, for supporting staff in writing articles for conferences and journals, and for writing grant proposals. Senior staff often write international peer-reviewed journal articles collaboratively with research assistants and other ECRs. Research Assistants are always named as co-authors, often as lead authors. The Department hosts workshops and expositions that include a mixed population of staff, ECRs and students, providing new researchers access to the latest research and also to an audience for their work. In September 2016, Goldsmiths submitted a revised action plan for 2016-20 and retained the HR Excellence in Research Award from the European Commission award, first awarded in September 2012 Goldsmiths' Central Services offers support for ECRs in line with the UK's Concordat to Support the Career Development of Researchers. Career guidance and other development opportunities (e.g. Postgraduate Certificate in the Management of Teaching and Learning, which uniquely combines pedagogic training with discipline-specific topics and politico-ethical focus) are available to staff *at all levels*, including research staff.

Career Development. Staff members meet with their line managers at least annually to discuss their academic work and career development. This can, on a voluntary basis, be part of the Performance Development Review (PDR) scheme, which includes a written preparation document, a one-to-one discussion, and an agreed written conclusion. All members of academic and research staff are offered a PDR annually, with their line managers or the head of department, to reflect on their careers, working towards individual and research group goals. These sessions are available to both permanent and fixed-term research staff. All research-active staff are assigned to at least one of the research groupings, which provides opportunities for collaborative working and guidance from research leaders. Staff are routinely supported, by Department Research Committee funds, to attend conferences and to, in other ways, further their research careers. The Department workload model is designed to encourage and reward research activity: it has a sliding scale of research time allocation based on achievement and potential. The research time includes, as well as output generation, grant writing and editorships and other professional research activities. Staff are entitled to apply for research sabbaticals through the College Research Office and are also encouraged to apply for research buyout time from funding bodies. In REF2014, we reported that two ECRs from RAE2008 (Gillies and Grierson) had been promoted to senior lecturers. Gillies is now a reader and Grierson is a professor. Promotions, supported by the Department, in the present REF period include: Fiebrink to reader, Devlin, Katan, and Papadopolous to senior lecturer; Maolino and Wiseman from post-doctoral research fellow to lecturer.

Equality and Diversity. In line with the discipline at large, women remain underrepresented in the Department, although the situation is improving. In this submission, 10 of the 41 REF returned

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members of staff are females (24%), whilst submitting 27% of the outputs. This is an improvement on the 2014 Goldsmiths' Computing REF submission, which was about 21% women (which, in turn, was more balanced than the national average of computing submissions at about 18% women). In the present REF period, 35% of the new academic appointments went to women. The improvement from 2014 to 2021 is part of an ambitious Departmental project targeted at increasing the role of women in computing. In April 2015, the Guardian newspaper printed an article that profiled women in Goldsmiths' Computing. This article was prompted by a targeted recruitment campaign, aimed at increasing the percentage of women in the Department. Also, in 2015, we started a project entitled "Women in Computing", in which women game programmers at Goldsmiths inspired female pupils and students to consider careers in computing. This is a Departmental priority. In 2018-19, Zimmer co-chaired (with the Deputy Warden), the Goldsmiths' College-wide Athena SWAN Self-Assessment Team (SAT), spearheading the College's first submission for the award. He also chaired the SAT for the Department in that period, leading to a submission at the same time as the College one. The Departmental Management Team now has a majority of women members (4 out of 7 members), including the new Chair of the Athena SWAN SAT, Director of Research and the Deputy Head of Department and Department Business Manager.

There is a Departmental policy of pro-actively soliciting promotion applications from appropriate staff members who have not put themselves forward, particularly women. In the REF period, 57% of internal promotions went to women, despite the fact that the Department is still predominantly male. The Department supports family and personal obligations of its staff members: 8 members of staff have agreed flexible-working arrangements, 7 of whom need the arrangements for childcare. These staff members are protected from teaching and other duties that require University attendance in especially pressured times. This was in place well before the pandemic, but the flexibility has become more important and more extensive due to lock-down induced home schooling and caring responsibilities.

Goldsmiths' Computing is committed to supporting and promoting BAME computer scientists. In 2020, the Department hosted a series of externally facilitated all-day workshops for academic staff to explore issues of unconscious bias and race equality. For four years, Computing's Ohene-Djan held a Goldsmiths-wide role of Associate Pro-Warden in charge of *Widening Access and Student Opportunity*. That role has now been focussed in the sense that he is concentrating on STEM subjects and widened in the sense that it includes research and academic staff. The cohort submitted to REF includes 22% BAME colleagues, who are submitting 23% of the outputs. This is a marked change from the 4% in the 2014 submission. We are aiming for this trend to continue. Our students are predominantly BAME and we actively encourage, through interventions in schools and targeted master classes, inner-city BAME students to study Computing at Goldsmiths. Moreover, our prominence on the Coursera platform enables us to reach thousands of students from diverse backgrounds. We hope, long-term, to develop these students through our own, and other post-graduate programmes, to help diversify the discipline.

Supporting PGR students. PhD students are an integral part of our research environment, playing an active part in all research activities from grant preparation to paper writing and presenting at Department seminars. We have a separate research committee to support post-graduate researchers. That committee, chaired by the Post-Graduate Tutor, Badkobeh, meets termly to discuss PGR students' progress and to allocate funding for students to attend conferences or in other ways support their research. The budget for PhD student travel is twice the

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budget for staff travel and it is expected that every student will get a chance to attend at least one conference, or equivalent, during their studies. Research students attend and present at local seminars, including the weekly research at lunchtime seminar series. We run two doctoral research programmes: Arts and Computing Technology (ACT) and Computer Science each led by a set of senior staff who coordinate collaborative activities within the cohort. ACT was one of the first practice-based PhDs in the University of London. Students on the programme produce both art and technology outputs and reflect on the relations between the two. This PhD programme is a clear reflection of our research philosophy and practice. All students on all programmes have two supervisors, often with one from a department outside Computing. We are part of two Doctoral Training Centres: *Intelligent Games and Games Intelligence* (IGGI) is a joint centre with York and QMUL. IGGI students study for 4 years, with an initial year that includes taught modules. The other centre is an AHRC-funded consortium devoted to Humanities and Arts PhDs in South-East England. Student progress is monitored through an online system in which notes of supervisions are kept, as well as records of engagement with training, and other aspects of PhD progression. Students write a report at the end of their first year. All research students begin as MPhil students. To become a PhD student, they need to upgrade through a process that involves writing two chapters and submitting to a viva. This upgrade provides a natural point to exit with an MPhil if the panel and/or student feel that progress to date does not provide confidence that the student will produce a PhD thesis. During this REF period, our PhD students have won several prizes, including: Donnarumma who won the *Prix Ars Electronica* for a performance integrating muscle interaction and machine learning and Ayoub who won a Santander student entrepreneur top prize for her glove that automatically translates from speech to sign language.

3. Income, infrastructure and facilities

Strategies for generating research income

The strategies for generating research income are directed by the overarching research aims; to keep the core research values in creative computing, actively planning for a thriving research future, be open to new ideas, explore new computer science foundations, focus on research that makes a difference and draws from and adds to department teaching.

The strategies for generating research income are:

(1) Diversify national sources of research income. Our research is intrinsically collaborative and interdisciplinary and benefits from a greater variety of funding sources compared to the previous REF period. This is evidenced by the diversity of research councils funding our research: EPSRC, AHRC, BBSRC, ESRC, Leverhulme and Alzheimers Research UK. Cross-disciplinary grants include: Crawford (AHRC) 'Transforming Musicology' (£1,6M); Pan (AHRC) 'Immersive Art and Tech: the use of immersive technology in performance art' (£488K); Soldatova (EPSRC) 'Action on Cancer' (£500K); Buchan's (BBSRC) grant enhancing the PSIPRED workbench using deep learning (£138K); Tanaka (ESRC) 'Art, Artifice & Intelligence: A UK-Japan partnership exploring art and AI' (£50K); Pan (AHRC/UKRI) works with universities, arts institutions and creative industries in the UK and China (£449K); Stamate (Alzheimers Research UK) 'Predicting risk of dementia using routine primary care records' (£110K); Gillies (Leverhulme) 'Understanding and Generating Real-time Face to Face Social Interactions' (£22K).

(2) Increase research income internationally. Our research benefited from collaborations in Europe and beyond: Rapidmix (Horizon 2020, €2.2M) involves both academic and commercial

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partners in France and Spain; Fiebrink (EU Marie Curie, €213K) is hosting Gamez-Djokic from Amsterdam to study brain activity and machine learning; Tanaka (ERC Executive Agency) 'Metagesture Music' (£1.4M); Ward (ERC) 'Neurolive' studying brains and theatrical performance; (€184K), Soldatova (CHIST-ERA, €1.5M) involved academics from France and Belgium; Soldatova was involved in the Big Machine Science project (DARPA, \$4.5M) – international network led by Chicago; Latham and Leymarie hosted two international art & technology symposia with Kyoto University; and we recently won funding for Hybrid Live (£67K) - a collaboration with Stanford, and cultural institutions in San Francisco and London.

(3) Increase research income from commercial partners. We attracted substantial funding from, or to support working with, commercial partners: Bishop Deep360 (£362K) is funded by UK company; Hoban's research is supported by a Silicon Valley company; Innovate UK funds Goldsmiths work with London companies, e.g. Bishop's KTP project, 'CHROMA' (£187K) with Sherwin-Williams, Gillies's 'Maze Theory' with the producers of a video game based on *Peaky Blinders* (BBC2 gangster drama). There has also been a shift from relying on the traditional sources of funding towards seeking other opportunities with US, Asian and UK private funding streams that are both altruistic and commercial in nature.

The total Department research income over the reporting period is £9,237,970, which on average is around a 30% increase per year on income reported in REF2014. Our average per-head funding is £236,871 for the 7-year period. These numbers show sustainability and expansion of our research in accordance with our research strategy.

Directed by the research strategies and strategies for generating research income, Goldsmiths' Computing embraced and enhanced the interdisciplinary nature of its research, maintained the core research area and expanded to new areas in data science, quantum computing, biomedicine and AI. Our projects led to outstanding outputs (see the submitted REF outputs and significance statements).

Organisational Structure Supporting Research and Impact

Goldsmiths' Computing provides a supportive and inclusive research environment to all staff, enabling realisation of its research strategies for sustainability and expansion to new areas.

The Goldsmiths' College Research Office is a reliable source of support. It distributes monthly newsletters outlining funding opportunities, invites external experts to run grant writing workshops, helps with funding applications and post-award matters. PIs are able to use 10% of the College FEC overheads for the furtherance of their research aims. This incentivises and rewards grant writing activity. It also provides opportunities for individuals and groups to come together and support ECRs, blue skies research, etc.

The Computing Department is also a source of support, employing four administrators dedicated to supporting research and enterprise. Bellamy is the research manager: she proactively helps academics (particularly ECRs) to find and apply for grant opportunities, helps academics with the applications, and manages the portfolio of grants. She directly approaches relevant researchers with suggestions, requests, and reminders. Bellamy produces a termly newsletter that celebrates Departmental successes such as research awards, publications and prizes, to keep the community up-to-date and to encourage collaborations. MacDonald is the industry engagement champion: she

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manages the interactions with commercial organisations, scoping opportunities for contract research, joint research and student placements. Falconer is the administrative lead for Goldsmiths' Digital Studios. She manages an in-house consultancy that runs small-scale commercial projects with local SMEs. Such projects are an opportunity for the researchers in the Department to foster new collaborations, try out new ideas, and carry out pilot studies. Geller, the student experience and marketing coordinator, makes sure that our research is publicised through websites, fora, and social media outlets. Researchers are informed by email and web announcements about seminars, public lectures, and funding opportunities. The Departmental research support team also supports blue-sky research which might not lead to funding bids but contributes to diversity and sustainability of our research environment. We see this as a valuable way of maintaining the vitality of the research culture: grant-getting is not a necessary condition for career progression.

The Research Committee. The Director of Research, Soldatova, is a member of the Department Management Team (DMT), where she reports and discusses research matters regularly. The Director of Research chairs the Departmental Research Committee, which organises seminars, away-days, strategy discussions, and regular seminar series in which every post-doctoral research staff member and PhD student is encouraged to present work several times a year. The Committee also allocates seed-corn grants, particularly to help ECRs with travel for collaboration and conference participation. The annual budget assigned for these grants is £12,000, supporting ten staff members and ten PhD students each year. The Research Committee meets at least termly to monitor and encourage department research. The Committee, as well as supporting staff and travel, supports visits of academics from other institutions and research events. In this period, we were particularly pleased to be able to support public events in the Games and VR and in Creative Machines.

Physical Infrastructure and facilities

Goldsmiths is an urban single campus university in South-East London. The college buildings are a mixture of purpose-built buildings and converted residential and civic buildings. The Computing Department is spread out across offices in converted Edwardian terrace houses, that contribute to its unique character; to computing lab spaces in newer or more specifically converted buildings: for example, PhD students and some staff are located in the Ben Pimlott Building, a modern iconic building that Goldsmiths uses on all its branding. Some of our labs and teaching happen in a deconsecrated church. The church is used, on occasion, as an exhibition space, including for the Computing Department's Computational Arts shows, for public engagement events, and for research conferences and workshops. For example, the church was used as an exhibition space for the *Future Minds: Art and Technology in the Future* conference that we jointly ran with Kyoto University.

During the reported period, we substantially expanded our research infrastructure and facilities to accommodate the needs of a steadily growing number of staff, their expanding research interests, new collaborations and partnerships. The research facilities we invested in support our core research in creative computing and arts. The SIML Lab discussed below is a state-of-the-art facility funded initially by the EPSRC, but the facility has created an asset where future bids could be possible as a result of this new resource. There has been an active investment in audio visual facilities in the Department to support the large growth of Virtual Reality projects in the Department (notably the work of Latham, Fol Leymarie, Gillies and Pan).

Two specialist spaces for interdisciplinary Goldsmiths' research in creating and performance: The **Sonics Immersive Media Lab (SIML)** is a state-of-the-art immersive audio/visual facility, offering a sprung floor, seamless surround video mapped across 6 high powered video projects, and surround sound on a 12.2 PA system. Building and equipping SIML was partially funded by the EPSRC capital equipment fund related to our IGGI Doctoral Training Centre. SIML accommodates audiences of up to 40 people. It is a Computing-managed space, available to ECRs and PhD students, and is used for inter-disciplinary research with other departments. It helps in exploring new research agendas and supports local/public engagement, e.g. making TV programmes.

SIML was used in two AHRC-funded *Immersive Experience* grants to develop content that toured internationally. Based on work developed in SIML, Tanaka was invited to present an immersive audiovisual performance at the IX Symposium in Montreal (2018); London artists *People Like Us* used SIML to finalise production of, and host a VIP screening of, an immersive cinema piece, *Gone Gone Beyond*. The piece was part of the Recombinant Festival in San Francisco. PhD student, Youhong Peng, created a portable SIML and presented an immersive dance performance work, *Skin Awareness*, originally created in SIML, at the ACM Motion Computing (MOCO) conference in Arizona in 2019. In 2017, the BBC news documentary '*Weapons of Mass Surveillance*' was partially filmed in the space. The documentary incorporated generative, real-time custom graphics software developed as part of Goldsmiths' Computing research. The director, Elizabeth Jones, wrote: "The artistic work itself was superb and worked perfectly and is probably what people comment on most when they watch the film."

The Hatchlab is a digital fabrication facility, realising mental images and digital designs as physical objects. The Hatchlab is equipped with a laser cutter, FDM and SLA 3D printers, vinyl cutter, CNC mills and routers, 12 fully equipped electronics development workbenches (including inductive soldering stations), oscilloscopes and bench power supplies, metal-engraving laser for printed circuit board prototyping, high-end woodworking equipment, as well as manually operated machinery, such as sander, drill press, jigsaw and more. The Hatchlab supports a number of research projects that involve either building objects from code or producing physical objects that contain code/electronics. The space hosts an artist-in-residence summer programme co-organised with the Victoria and Albert Museum. The Hatchlab has been also used for commercial projects and for commercial/Goldsmiths collaborations

Three other specialist spaces support the Department's research in creating and consuming media: **Filming Studios** the **XR Lab**, and the **Motion Capture Suite**.

Recently, we installed two professional-level innovative **Filming Studios**. These studios were built to support our online programmes but are increasingly supporting research and public engagement, for example online scientific presentations. Studio facilities accelerate our creation of high quality pre-recorded and live video content. Academics can use the systems in self-recording mode, switching between camera angles, and background video feeds using our own custom controller software. We use the studios for live webinars, controlling the composition and layout of the stream in real-time.

The **XR lab** is a two-room space equipped with a range of state-of-the-art VR and AR equipment. The main room is for technical work and collaboration and the second for specialist technical work and demos. The joint pre-covid capacity was 40. The labs house 10 sets of high-end VR headsets

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with graphics workstation PCs, a Hololens 2 AR headset, two AR glasses, several 360 video cameras, and a professional motion capture system (optitrack). We use the lab for VR research including models of micro-biology, models of social situations, and games characters. The space is used by PhD students and postdocs for running experiments and research demos. It is also used in research events such as the 2019 Innovate UK Workshop. It has also been with commercial collaborators, including HTC VIVE, and Mindbubble, a London-based start-up. The space is large enough to be both a technical working space and a social space for our researchers and collaborators, allowing PhD and masters students to work alongside each other.

The **Motion Capture Suite** is an annex to the XR Lab. In the suite, multi-camera motion capture technology records people's movement and renders it into a virtual world in real time: the actor controls an avatar in VR. 8.1. Ambisonic Surround generates a cube of precisely located sound. Customised Oculus Rift and LEAP Motion equipment enables free exploration of a virtual version of the room. The virtual reality and motion capture rooms together provide a powerful support for motion tracking for VR research.

On a more basic level, most of the Department's research is supported by researcher's individual machines or one of over 200 iMacs housed in our four dedicated computer labs.

4. Collaboration and contribution to the research base, economy and society

In line with our **research strategy**, staff made major contributions to sustaining and developing the area of creative computing (**stable and sustainable**) and extending interdisciplinary engagements, both within the UK and internationally (**expansive**). The Department maintains relationships with a wide range of non-academic users, stakeholders and beneficiaries (**placed in the world**), including: charities, creative-sector SMEs, cultural organisations, large industries, and the general public. Staff are supported through training, and internal and external resources to deliver research that has impact, reach and significance. We are particularly proud that we have demonstrated how Creative Computing makes a difference within and beyond the academy.

Research collaborations, networks and partnerships

Collaborations are central to our research, particularly research networks that cut across discipline boundaries. The key indicators of their success are joint applications for funding and publications - the vast majority of our submitted outputs are by multiple co-authors from different institutions. These collaborations have enriched the research environment, widened our research horizon, enhanced our national and international standing, and contributed to research-led teaching. The examples in this section demonstrate national and international collaborations in many research areas, including in creative computing, AI, systems biology, neurology, and musicology.

International Funding Networks: In the REF period, Goldsmiths Computing was involved in eleven European projects: Colton (EU FP7: WHIM, COINVENT, PROSECCO), Crawford (H2020, TROMPA), d'Inverno (EU FP7, PRAISE, CHISTERA ACE), Soldatova (EU FP7 CHIST-ERA AdaLab), Tanaka (FP7 ERC, Metageature Music, EU H2020: RAPID-MIX, BIOMUSIC), Ward (EU H2020: NEUROLIVE, SOCSENSORS). Soldatova was a PI in Goldsmiths of the Big Machine Science project funded by DARPA (\$4.5M). This project was part of the \$45M DARPA Big Mechanism programme, aimed at automatically processing scientific literature to develop

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executable models. This work led to subsequent funding for Soldatova from the EPSRC as the ACTION on cancer project.

UK Funding Networks: York, QMUL, Falmouth, and Goldsmiths were awarded £18M to develop research in VR, digital art, data visualisation and graphics, for the benefit of science, society, education and culture as an EPSRC-funded network, called *Digital Creativity (DC) Hub*. The DC Hub employs 15 researchers. This work builds on a previous grant to transfer knowledge and expertise gained from £90M of investment in digital creativity research at Goldsmiths, York, Falmouth and Cass Business School over the last decade. Crawford was the PI on the AHRC-funded *Transforming Musicology* grant with partners at Oxford, QMUL, Lancaster, and Utrecht. This was the largest grant (£1.2M) in the Digital Transformations programme.

Individual Collaborations: Latham and Leymarie have collaborated with three groups of biomedical researchers who all see value in Goldsmiths VR as a way of experiencing molecular biology: Sternberg at Imperial, Twarock at York, and Taylor at Oxford. Similarly, Buchan's collaboration with Jones at UCL led to a recent BBSRC grant, bringing Deep Learning to Virus Identification. The grant builds on Buchan and Jones's previous work on the PSIPRED Workbench, which enables about 500 unique users a month to run machine learning predictors over protein data. Stamate works with Reeves at Manchester on work funded by Alzheimer's Research UK, that uses machine learning for early diagnosis of Alzheimer's. Casey in collaboration with Rockmore, Dartmouth College, organised the world's first Turing Tests in the Creative Arts, Competitions. D'Inverno long-established academic relationship with Sierra, (Director of IIIA Institute of AI at the University of Autonomia in Barcelona) and Pachet (Spotify) have led to EU projects, publications, software and performances, related to AI and Music.

Engagements with research users, beneficiaries or audiences to develop impact

Our engagement activities are aligned with the research strategy of doing research that makes a difference to individuals, charities, companies, and universities. Staff actively promote our vision of computing as a creative practice through engagement with artists and art audiences and take it further through engagement with science audiences, companies and general public, as seen from the examples below.

Engagement with Artists. The Wekinator, machine learning software, designed and implemented by Fiebrink, has achieved major worldwide impact for developers of music and games applications, music and dance performers, and the public. It was featured by BBC and Daily Mail and in venues such as the Roundhouse and The British Library. Yee-King's music-creation software improvised jazz live on a Radio 3 jazz programme.

Engagement with Arts Audiences. D'Inverno featured in a Sky-Arts documentary discussing the relationship between Computation and Creativity. As part of the *Late at Tate*, Frenred showed [three installations](#) in Tate Britain. Forth participated in Radio 3 Music Matters programme about musical memory in collaboration with The Wellcome Collection. He collaborated with choreographer Janine Harrington to organise dance/live code/generative music performances at many venues, e.g. The Victoria and Albert Museum, V&A Museum of Childhood, INKONST Malmö (Sweden), Dance Umbrella Festival Siobhan Davies Studios London, TripSpace London, UK Dance showcase, Poole, and MOCO Conference. Ward, in collaboration with UCL, Flute Theatre, Shimadzu ran a series of live public research talks and performances exploring wearable sensing,

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theatre, and the brain at the Bloomsbury Theatre. This led to a week of performances at the Bridge Theatre involving Flute and autistic children. This work won the 2020 Goldsmiths Public Engagement Award. Raskob exhibited sculptures made with the [LivePrinter](#) project at the Design Research for Change Exhibition at London Design Festival in 2019.

Engagement with Science Audiences. Soldatova's exhibition of the [Robot Scientist](#) in the Science Museum attracted 3,500 visitors who learned about computational approaches for drug discovery through demos and games. Maiolino's Robot skin was also displayed at the Science Museum. Visitors to New Scientist Live, and to the Royal Society Summer Exhibition, learned about VR and about the structures of viruses and DNA through Latham and Leymarie's exhibitions. Pritchard invited local citizens to participate in their research project on the air quality monitoring. The results of this project were used in the representations made by the local community to the Parliament.

Engagement with General Audiences through Public Lectures. Researchers in the Department have given over 100 public lectures including Lotto's [TED talk](#) about Awe that involved a love performance from the Cirque du Soleil (viewed over a third of a million times as of January 2021) and his talk at the World Economic Forum. Latham gave a [TEDX Talk](#) about computer generated, organic life forms. Falconer gave a talk and chaired a panel on *AI bias and Feminism in the Music Industry*. Raskob gave a public talk in the episode of Bar Arduino Worldwide (99.5K subscribers). Hughston gave a public lecture in Casablanca Stock Exchange, Morocco (May 2014).

Engagement with Companies, especially Creative Industries SMEs. We have worked with companies from the largest (including Microsoft, Adobe and Google) to the smallest, to ensure our research makes a difference in the world. A particular feature is Goldsmiths' Digital Studios, (described in Section 1). In this period, this work was supported by an initiative called *London Fusion Collaborative Awards* as part of Creativeworks. In the REF period, we worked with: *Ribui Ltd*, to make augmented reality apps for the culture sector; *Performance and Wellbeing Ltd* to design and implement a cloud-based application to capture and reuse health information; *Such and Such Design Ltd* to produce an online, mobile platform providing assistive technologies for disabled and elderly people; *Intatex – ReWorkKsl* to produce a web-based application for recycling surplus textiles; *Enternships* to innovate new intelligent search techniques for an online job board; *AUM Investments Limited Trading*, to produce a sound-based messaging system for the music industry; *NeuroCoach Limited* to produce cloud-based services for tracking biodata. *Desktop Genetics* to produce visualisations of biological features found in large DNA databases

Engagement with Charities. Our work with charities ensures that our research makes lives better. For example, Fiebrink led a project on providing systems that help disabled children express themselves musically. Ohene-Djan worked with *Mind* to produce systems to help sufferers of depression to find support during the pandemic. This work was followed-up by a QR-based system providing physical interventions aimed at preventing suicide in young men.

Wider activities and contributions to the research base

Reaching wider audiences has been an important dimension of our research strategy because it enables the development of impact for existing research expertise, stimulates further enquiry, and instigate new collaborations. The Department supports community engagement and leadership by

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providing funding for travel and community engagement, and by recognising substantial external responsibilities in its workload model through the tier system. As evidenced below, staff have been successfully representing and promoting our vision of creative computing through serving on advisory and management boards, editorial boards, programme committees, and giving invited and keynote talks.

Advisory/Management Boards: 34 in total. Examples: Latham (Board of Directors of USC-SJTU Institute of Cultural and Creative Industries of Shanghai Jiao Tong University), Soldatova (EPSRC ICT prioritisation panel), Russell-Rose (vice-chair of the BCS Information Retrieval Specialist Group); Ward (technical advisor for LiveTree Ltd), Leymarie (co-director of DynAlkon Ltd), Fiebrink (Research Council of Norway Centre of Excellence, Advisory Board), D’Inverno (HEFCE’s Research and Knowledge Exchange Strategic Advisory Board).

Editorial Board Memberships: 39 in total. Examples: Gillies (Virtual Reality (Springer), Associate Editor), Pan (Frontiers in Virtual Reality, Associate Editor), Ward (Frontiers in Computer Science (Mobile and Ubiquitous Computing), Associate Editor), Soldatova (Journal of Machine Learning, Special issue on Discovery Science, Lead Guest Editor), Leymarie (Arts (MDPI), The Visual Computer (Springer); Associate Editor). Hughston (International Journal of Theoretical and Applied Finance, Editor-in-Chief).

Programme Committee Chair/Co-Chair/Track Chair: 66 in total. Examples: Lewis (Digital Libraries for Musicology, General Chair); Gillies (4th International Symposium on Movement Computing, London, Chair); Pan (Scientific VR Workshop, The Francis Crick Institute, Chair), Ward (International Symposium on Wearable Computers (ISWC), ACM, Co-Chair), Soldatova (Discovery Science’19, Co-Chair), Leymarie (Workshop on Artistically Skilled Robots, IEEE IROS, Principal Chair), Casey (Music and AI Competition, Neukom Institute Turing Tests in the Creative Arts, Chair).

Fellowships/Prizes/Awards/Named Lectures/Public Engagement: 30 in total. Examples: Crawford (BL Labs Research Awards, the First Prize), Yee-King (Google research Award in AI, sound synthesis work), Ward (APEX Award), Hoban (Paul Ehrenfest Best Paper Award for Quantum Foundations), Badkobe (Leverhulme Early Career Fellowship), Gamez-Djokic (Marie Skłodowska-Curie Fellowship).

Keynote/Invited Talks: 145 by members of staff in total and additionally over 200 talks by Lotto. Examples: Casey (Reconstructing Music Stimuli from fMRI, North-East Music Cognition Group (NEMCOG), Harvard University, Keynote); Ward (Wellcome Trust Centre for Neuroimaging, UCL, London, Invited), d’Inverno (Lego Ideas Conference, The Conference, Music Most Wanted, AI for Good), Yee-King (AI for Good Global Summit, Invited), Pan (the 2nd European Congress for Social Psychiatry, Switzerland, Invited), Latham (NWR Museum, Dusseldorf, Keynote), Crawford (Music Encoding Conference, USA, Keynote), Hughston (International Conference on Quantum Control, Mexico City, Invited), Garagnani (Oliver Zangwill Club Talks Series, Department of Psychology, University of Cambridge, Invited), Blackwell (Computer simulation of musical creativity conference, Dublin 2018, Keynote), Putnam (International Symposium on Electronic Art, Keynote), Leymarie (“Drawing, Gestures, Robots”, ACM Symposium, Keynote), Lotto (invited to speak about 200 times in the period, including at Apple, Google, Microsoft, McKinsey).

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Some research collaborations led to visiting positions, for example Tanaka was guest professor at Technical University of Berlin (Summer 2019) funded by the Deutscher Akademischer Austauschdienst. The visit ended with a public symposium at the German State Musical Instrument Museum. Gillies is a Visiting Senior Lecturer at UCL Institute of Cognitive Neuroscience.

Hosting events. We support the research base not only by organising and speaking at events, but also by providing a London venue for international research events. In the REF period we hosted: [Future Mind](#): art & tech symposium with collaborators at Kyoto University; [Eavi-Live](#): (Embodied AudioVisual Interaction) a day of audiovisual workshops and performances at the ICA (Institute of Contemporary Arts); [Human Interactive Conference](#); the [MOCO](#) (Movement and Computing) conference; [Virtual Social Interaction 2018](#); [Innovation in Immersive Art & Tech](#): a Goldsmiths UK-China Workshop; [Art, AI-created content, & industrial/cultural effects](#); Transforming Musicology – Looking to the Future, Oxford (musicology and digital technologies); a series of London-Paris Workshops initiated by Hughston with Pennanen (KCL) and Gobet (Ecole Polytechnique, Paris) (the 2015 meeting in London was supported by a grant from the London Mathematical Society).