RESEARCH CENTER
Lille - Nord Europe

FIELD

Activity Report 2018

Section Application Domains

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GAIA Team

4. Application Domains

4.1. Adaptive & parametric robust control – collaboration with Safran Electronics & Defense

We have developed a collaboration with *Safran Electronics & Defense* (Massy Palaiseau) and Rouillier (OURAGAN, Inria Paris) on a *parametric robust control theory* based on computer algebra methods (symbolic-numeric methods), as well as its applications to the robust stabilization of certain mechanical systems (e.g. gyrostabilized systems, two mass-spring-damper system, stabilized mirrors).

For low-dimensional systems of ODEs, this approach aims to determine closed-form solutions for robust controllers and for the robustness margins in terms of the model parameters (e.g. mass, length, inertia, mode) [12], [98], [100]. The main applications of these results are twofold: the feasibility of an industrial project can be simplified by speeding up the computation of robust controllers and robust margins for systems with rapidly changing architecture parameters, and avoiding usual time-consuming optimization techniques. Secondly, adaptive and embeddable schemes for robust controllers can be proposed and tested while coupling our approach with real-time parameter estimation methods such as the ones developed in the GAIA team. For more details, see [12].

Preliminary works in the direction have opened a great variety of questions such as the explicit search for positive definite solutions of algebraic or differential Riccati equations (i.e. polynomial or differential systems) with model parameters, the reduction of these equations, and of the parameters based on symmetries, the development, of efficient tools for plotting high degree curves and surfaces showing the robustness margins in terms of the model parameters (collaboration with Moroz (GAMBLE, Inria Nancy)), the use of a certified numeric Newton-Puiseux algorithm for the design of robust controllers, etc. [12], [98], [100]. These results require the use of a large spectrum of computer algebra methods such as linear algebra with parameters, polynomial systems with parameters, ordinary differential systems with parameters, symmetries and reduction, rational parametrizations, discriminant varieties, semi-algebraic sets, critical point methods, real root isolation methods, etc. We shall further develop the parametric robust control in collaboration with *Safran Electronics & Defense*.

In connection with the above results, parameter estimation methods will be studied to develop *adaptive robust controllers* for gyrostabilized systems. Indeed, combining explicit characterizations of robust controllers in terms of the model parameters with time-to-time estimations of these model parameters (which can change with the system production, the heat, the wear, etc.), the robust controllers can then be automatically tuned to conserve their robustness performances [12], [99].

Finally, as explained in [11], [99], constant and distributed delays naturally appear in *Safran E & D* systems (e.g. gyrostabilized systems using visual trackers, stabilized mirror models). Extensions of the above problems and results will be studied for differential time-delay systems based on robust control techniques for infinite-dimensional systems (see, e.g., [54] and the references therein) and its algebraic extension to include model parameters.

4.2. Self calibration problem & Gear fault diagnosis – collaboration with Safran Tech

4.2.1. Self calibration problem

Due to numerous applications (e.g. sensor network, mobile robots), sources and sensors localization has intensively been studied in the literature of signal processing. The *anchor position self calibration problem*, a well-known problem in signal processing, consists in estimating the positions of both the moving sources and a set of fixed sensors (anchors) when only the distance information between the points from the two different sets is available. The position self-calibration problem is a particular case of the *Multidimensional Unfolding* (MDU) problem for the Euclidean space of dimension 3.

Based on computer algebra methods for polynomial systems, we have recently proposed a new approach for the MDU problem which yields closed-form solutions and an efficient algorithm for the estimation of the positions [56] only based on linear algebra techniques. This first result, obtained in collaboration with Dagher (Research Engineer, Inria Chile) and Zheng (DEFROST, Inria Lille - Nord Europe), yields a recent *patent* [55]. Real tests are now carried out. Our first results will be further developed, improved, tested, and demonstrated.

The MDU problem is just one instance of localization problems: more problems can be addressed for which a computer algebra expertise can brought new interesting results, especially in finding closed-form solutions, yielding new estimation techniques which avoid the use of optimization algorithms as commonly done in the signal processing literature. The main differences between these localization problems can essentially be read on a certain matrix of distance called the *Euclidean distance matrix* [56].

4.2.2. Gear fault diagnosis

We have a collaboration with Barau (*Safran Tech*) and Hubert (*Safran Tech*), and Dagher (Research Engineer, Inria Chile) on the symbolic-numeric study of the new multi-carrier demodulation method developed in [71]. *Gear fault diagnosis* is an important issue in aeronautics industry since a damage in a gearbox, which is not detected in time, can have dramatic effects on the safety of a plane.

Since the vibrations of a spur gear can be modeled as a product of two periodic functions related to the gearbox kinematic, [71] has proposed to recover each function from the global signal by means of an optimal reconstruction problem which, by means of Fourier analysis, can be rewritten as

$$\mathrm{argmin}_{u\in\mathbb{C}^n, v_1, v_2\in\mathbb{C}^m} \|M - u\, v_1^{\star} - D\, u\, v_2^{\star}\|_F,$$

where $M \in \mathbb{C}^{n\times m}$ (resp. $D \in \mathbb{C}^{n\times n}$) is a given (resp. diagonal) matrix with a special shape, $\|\cdot\|_F$ denotes the Frobenius norm, and $v^{\star}$ the Hermitian transpose of v. Based on closed-form solutions of the exact problem − which are defined by a system of polynomial equations in the unknowns − we have recently proposed efficient numerical algorithms to numerically solve the problem. The first results are interesting and they will be further developed and tested on different data sets. Finally, we shall continue to study the extremal solutions of the corresponding polynomial problem by means of symbolic and numeric methods, etc.

4.3. Applications of the parameter estimation problem to multidisciplinary domains − collaboration with an INSERM team (Rouen University)

For linear systems, the closed-form expressions of the parameters obtained by means of the algebraic parameter estimation problem will continue to provide robust estimates in our multidisciplinary collaborations, in marine biology and human-machine interactions, as it is already the case of existing NON-A results (in collaboration with LOKI, Inria Lille - Nord Europe).

For nonlinear systems, a collaboration with biologists and modelers has been developed for a few years already [29]. Our partners are a team from the Applied Mathematical Department of Le Havre University (modelers) and an INSERM team at Rouen University (neurobiologists). The targeted biological problem is the cortical spreading depression, a brain disease likely to occur after cerebrovascular accidents [60]. We seek − ultimately − a mathematical integro-differential model permitting to predict the triggering of this disease for patients arising in the emergency services of hospitals. The key phenomenon to reproduce is a slow depolarization wave of neurons. Our approach is original because it focuses on the role calcium fluxes in neurons and astrocytes.

BONUS Team

4. Application Domains

4.1. Introduction

For the validation of our findings we obviously use standard benchmarks to facilitate the comparison with related works. In addition, we also target real-world applications in the context of our collaborations and industrial contracts. From the *application* point of view two classes are targeted: *complex scheduling* and *engineering design*. The objective is twofold: proposing new models for complex problems and solving efficiently BOPs using jointly the three lines of our research program. In the following, are given some use cases that are the focus of our current industrial collaborations.

4.2. Big optimization for complex scheduling

Three application domains are targeted: energy, health and transport and logistics. In the **energy** field, with the smart grid revolution (multi-)house energy management is gaining a growing interest. The key challenge is to make elastic with respect to the energy market the (multi-)house energy consumption and management. *This kind of demand-side management will be of strategic importance for energy companies in the near future.* In collaboration with the EDF energy company we are working on the formulation and solving of optimization problems on demand-side management in smart micro-grids for single- and multi-user frameworks. These complex problems require taking into account multiple conflicting objectives and constraints and many (deterministic/uncertain, discrete/continuous) parameters. A representative example of such BOPs that we are addressing is the scheduling of the activation of a large number of electrical and thermal appliances for a set of homes optimizing at least three criteria: maximizing the user's confort, minimizing its energy bill and minimzing peak consumption situations. In the **health** care domain, we are collaborating with the Beckman & Coulter company on the design and planning of large medical laboratories. This is a hot topic resulting from the mutualisation phenomenon which makes bigger these laboratories. As a consequence, being responsible for analyzing medical tests ordered by physicians on patient's samples, these laboratories receive large amounts of prescriptions and tubes making their associated workflow more complex. Our aim is therefore to design and plan any medical laboratory to minimize the costs and time required to perform the tests. More exactly, the focus is put on the multi-objective modeling and solving of large (e.g. dozens of thousands of medical test tubes to be analyzed) strategic, tactical and operational problems such as the layout design, machine selection and confguration, assignment and scheduling. Finally, in **transport and logistics**, within the context of our potential collaboration (being set up) with the EXOTEC company we target the optimization of the robotic logistics of 3D warehouses. More exactly, the problem consists in efficient complex scheduling without collision of thousands of missions realized by a fleet of dozens of robots and several operators in a 3D logistics warehouse. The problem is identified in the literature as the parts-to-picker based order processing in a rack-moving mobile robots environment.

4.3. Big optimization for engineering design

The focus is for now put on the aerospace vehicle design, a complex multidisciplinary optimization process, we are exploring in collaboration with ONERA. The objective is to find the vehicle architecture and characteristics that provide the optimal performance (flight performance, safety, reliability, cost, etc.) while satisfying design requirements [39]. A representative topic we are investigating, and will continue to investigate throughout the lifetime of the project given its complexity, is the design of launch vehicles that involves at least 4 tightly coupled disciplines (aerodynamics, structure, propulsion and trajectory). Each discipline may rely on time-demanding simulations such as Finite Element analyses (structure) and Computational Fluid Dynamics analyses (aerodynamics). Surrogate-assisted optimization is highly required to reduce the time complexity. In addition, the problem is high-dimensional (dozens of parameters and more than 3 objectives) requiring different decomposition schema (coupling *vs.* local variables, continuous *vs.* discrete even categorial variables, scalarization of the objectives). Another major issue arising in this area is the non-stationarity of the objective functions which is generally due to the abrupt change of a physical property that often occurs in the design of launch vehicles. In the same spirit than deep learning using neural networks, we use Deep Gaussian Processes to deal with non-stationary multi-objective functions. Finally, the resolution of the problem using only one objective takes 1 week using a multi-core processor. Therefore, *in addition to surrogates ultra-scale computing is required at different levels to speed up the search and improve the reliability which is a major requirement in aerospace design.* This example shows that we need to use the synergy between the 3 lines of our research program to tackle such BOPs.

INOCS Project-Team

4. Application Domains

4.1. Energy

In energy, the team mainly focuses on pricing models for demand side management. Demand side management methods are traditionally used to control electricity demand which became quite irregular recently and resulted in inefficiency in supply. We have explored the relationship between energy suppliers and customers who are connected to a smart grid. The smart grid technology allows customers to keep track of hourly prices and shift their demand accordingly, and allows the provider to observe the actual demand response to its pricing strategy. We tackle pricing problems in energy according to the bilevel optimization approaches. Some research works in this domain are supported by bilateral grants with EDF.

4.2. Transportation and Logistics

In transportation and logistics, the team addresses mainly integrated problems, which require taking into account simultaneously different types of decision. Examples are location and routing, inventory management and routing or staff scheduling and warehouse operations management. Such problems occur from the supply chain design level to the logistic facility level. Some research activities in this application domain are supported by bilateral grants/contracts with Colisweb, DHL, HappyChic, INFRABEL, and Kéolis.

4.3. Telecommunications

In telecommunications, the team mainly focuses on network design problems and on routing problems. Such problems are optimization problems with complex structure, since the optimization of capacity installation and traffic flow routing have to be addressed simultaneously. Some research works are conducted within a long-term cooperation with Nokia (formerly Alcatel-Lucent Bell Labs).

MEPHYSTO-POST Team (section vide)

MODAL Project-Team

4. Application Domains

4.1. Economic World

The Modal team applies it research to the economic world through CIFRE Phd supervision such as CACF (credit scoring), A-Volute (expert in 3D sound), Meilleur Taux (insurance comparator), ...It also has many contracts with companies such as Decathlon (world leader in sports equipment), Arcelor-Mittal (steel industry) or Alstom (integrated transport systems).

4.2. Biology

The second main application domain of the team is the biology. Members of the team are involved in the supervision and scientific animation of the bilille platform, the bioinformatics and bioanalysis platform of Lille.

NON-A POST Team (section vide)

RAPSODI Project-Team

4. Application Domains

4.1. Porous media flows

Porous media flows are of great interest in many contexts, like, e.g., oil engineering, water resource management, nuclear waste repository management, or carbon dioxyde sequestration. We refer to [57], [56] for an extensive discussion on porous media flow models.

From a mathematical point of view, the transport of complex fluids in porous media often leads to possibly degenerate parabolic conservation laws. The porous rocks can be highly heterogeneous and anisotropic. Moreover, the grids on which one intends to solve numerically the problems are prescribed by the geological data, and might be non-conformal with cells of various shapes. Therefore, the schemes used for simulating such complex flows must be particularly robust.

4.2. Corrosion and concrete carbonation

The team is interested in the theoretical and numerical analysis of mathematical models describing degradation of materials as concrete carbonation and corrosion. The study of such models is an important environmental and industrial issue. Atmospheric carbonation degrades reinforced concretes and limits the lifetime of civil engineering structures. Corrosion phenomena issues occur for instance in the reliability of nuclear power plants and the nuclear waste repository. The study of the long time evolution of these phenomena is of course fundamental in order to predict the lifetime of the structures.

From a mathematical point of view, the modeling of concrete carbonation (see [51]) as the modeling of corrosion in an underground repository (DPCM model developed by Bataillon *et al.* [55]) lead to systems of PDEs posed on moving domains. The coupling between convection-diffusion-reaction equations and moving boundary equations leads to challenging mathematical questions.

4.3. Complex fluid flows

The team is interested in some numerical methods for the simulation of systems of PDEs describing complex flows, like for instance, mixture flows, granular gases, rarefied gases, or quantum fluids.

Variable-density, low-Mach flows have been widely studied in the recent literature because of their applicability in various phenomena such as flows in high-temperature gas reactors, meteorological flows, flows with convective and/or conductive heat transfer or combustion processes. In such cases, the resolution of the full compressible Navier–Stokes system is not adapted, because of the sound waves speed. The Boussinesq incompressible model is not a better alternative for such low-speed phenomena, because the compressibility effects can not be totally cancelled due to large variations of temperature and density. Consequently, some models have been formally derived, leading to the filtering of the acoustic waves by the use of some formal asymptotic expansions and two families of methods have been developed in the literature in order to compute these flows. We are interested in particular in the so-called pressure-based methods which are more robust than density-based solvers, although their range of validity is in general more limited.

Kinetic theory of molecular gases models a gas as a system of elastically colliding spheres, conserving mechanical energy during impact. Once initialized, it takes a molecular gas not more than few collisions per particle to relax to its equilibrium state, characterized by a Maxwellian velocity distribution and a certain homogeneous density (in the absence of external forces). A granular gas is a system of dissipatively colliding, macroscopic particles (grains). This slight change in the microscopic dynamics (converting energy into heat) cause drastic changes in the behavior of the gas: granular gases are open systems, which exhibits self-organized spatio-temporal cluster formations, and has no equilibrium distribution. They can be used to model silos, avalanches, pollen or planetary rings.

The quantum models can be used to describe superfluids, quantum semiconductors, weakly interacting Bose gases or quantum trajectories of Bohmian mechanics. They have attracted considerable attention in the last decades, due in particular to the development of the nanotechnology applications. To describe quantum phenomena, there exists a large variety of models. In particular there exist three different levels of description: microscopic, mesoscopic and macroscopic. The quantum Navier–Stokes equations deal with a macroscopic description in which the quantum effects are taken into account through a third order term called the quantum Bohm potential. This Bohm potential arises from the fluid dynamical formulation of the single-state Schrödinger equation. The non-locality of quantum mechanics is approximated by the fact that the equations of state do not only depend on the particle density but also on its gradient. These equations were employed to model field emissions from metals and steady-state tunneling in metal- insulator- metal structures and to simulate ultra-small semiconductor devices.

4.4. Stratigraphy

The knowledge of the geology is a prerequisite before simulating flows within the subsoil. Numerical simulations of the geological history thanks to stratigraphy numerical codes allow to complete the knowledge of the geology where experimental data are lacking. Stratigraphic models consist in a description of the erosion and sedimentation phenomena at geological scales.

The characteristic time scales for the sediments are much larger than the characteristic time scales for the water in the river. However, the (time-averaged) water flux plays a crucial role in the evolution of the stratigraphy. Therefore, defining appropriate models that take the coupling between the rivers and the sediments into account is fundamental and challenging. Once the models are at hand, efficient numerical methods must be developed.

4.5. Low-frequency electromagnetism

Numerical simulation is nowadays an essential tool in order to design electromagnetic systems, by estimating the electromagnetic fields generated in a wide variety of devices. An important challenge for many applications is to quantify the intensity of the electric field induced in a conductor by a current generated in its neighborhood. In the low-frequency regime, we can for example quote the study of the impact on the human body of a high-tension line or, for higher frequencies, the one of a smartphone. But the ability to simulate accurately some electromagnetic fields is also very useful for non-destructive control, in the context of the maintenance of nuclear power stations for example. The development of efficient numerical tools, among which *a posteriori* error estimators, is consequently necessary to reach a high precision of calculation in order to provide estimations as reliable as possible.

SEQUEL Project-Team

4. Application Domains

4.1. Sequential decision making under uncertainty and prediction

The spectrum of applications of our research is very wide: it ranges from the core of our research, that is sequential decision making under uncertainty, to the application of components used to solve this decision making problem.

To be more specific, we work on computational advertising and recommendation systems; these problems are considered as a sequential matching problem in which resources available in a limited amount have to be matched to meet some users' expectations. The sequential approach we advocate paves the way to better tackle the cold-start problem, and non stationary environments. More generally, these approaches are applied to the optimization of budgeted resources under uncertainty, in a time-varying environment, including constraints on computational times (typically, a decision has to be made in less than 1 ms in a recommendation system). An other field of applications of our research is related to education which we consider as a sequential matching problem between a student, and educational contents.

The algorithms to solve these tasks heavily rely on tools from machine learning, statistics, and optimization. Henceforth, we also apply our work to more classical supervised learning, and prediction tasks, as well as unsupervised learning tasks. The whole range of methods is used, from decision forests, to kernel methods, to deep learning. For instance, we have recently used deep learning on images. We also have a line of works related to software development studying how machine learning can improve the quality of software being developed. More generally, we apply our research to data science.

BONSAI Project-Team (section vide)

FUN Project-Team

4. Application Domains

4.1. Application Domains

The set of applications enabled through FUN and IoT is very large and can apply in every application area. We can thus not be exhaustive but among the most spread applications, we can name every area, event, environmental or animal monitoring, understanding and protection. To illustrate this, we may refer to the use cases addressed by our AgriNet project which goals is to monitor vineyards and potatoes fields with smart communicating devices to fight against water waste.

Other field of application is exploration of hostile and/or unknown environment by a fleet of self-organizing robots that cooperate with RFID and sensors to ensure a continue monitoring afterwards.

Also, IoT and FUN can play a key role in logistics and traceability by relying on the use of sensors or RFID technologies as implemented in our STORECONNECT project or our collaboration with the start up TRAXENS.

Finally, IoT and FUN leverage a lot of applications in Smart City concept , ranging from parking aid to a better energy consumption going through air quality monitoring, traffic fluidizing etc. (See our CityLab Inria).

RMOD Project-Team

4. Application Domains

4.1. Programming Languages and Tools

Many of the results of RMoD are improving programming languages or development tools for such languages. As such the application domain of these results is as varied as the use of programming languages in general. Pharo, the language that RMoD develops, is used for a very broad range of applications. From pure research experiments to real world industrial use (the Pharo Consortium, http://consortium.pharo.org, has more than 25 company members).

Examples are web applications, server backends for mobile applications or even graphical tools and embedded applications

4.2. Software Reengineering

Moose is a language-independent environment for reverse and re-engineering complex software systems. Moose provides a set of services including a common meta-model, metrics evaluation and visualization. As such Moose is used for analyzing software systems to support understanding and continuous development as well as software quality analysis.

SPIRALS Project-Team

4. Application Domains

4.1. Introduction

Although our research is general enough to be applied to many application domains, we currently focus on applications and distributed services for the retail industry and for the digital home. These two application domains are supported by a strong expertise in mobile computing and in cloud computing that are the two main target environments on which our research prototypes are built, for which we are recognized, and for which we have already established strong collaborations with the industrial ecosystem.

4.2. Distributed software services for the retail industry

This application domain is developed in relation with the PICOM (*Pôle de compétitivité Industries du Commerce*) cluster. We have established strong collaborations with local companies in the context of former funded projects, such as Cappucino and Macchiato, which focused on the development of a new generation of mobile computing platforms for e-commerce. We are also involved in the Datalyse and OCCIware funded projects that define cloud computing environments with applications for the retail industry. Finally, our activities in terms of crowd-sensing and data gathering on mobile devices with the APISENSE® platform share also applications for the retail industry.

4.3. Distributed software services for the digital home

We are developing new middleware solutions for the digital home, in particular through our long standing collaboration with Orange Labs. We are especially interested in developing energy management and saving solutions with the POWERAPI software library for distributed environments such the ones that equip digital homes. We are also working to bridge the gap between distributed services hosted on home gateways and distributed services hosted on the cloud to be able to smoothly transition between both environments. This work is especially conducted with the SALOON platform.

DEFROST Project-Team

4. Application Domains

4.1. Industry

Robotics in the manufacturing industry is already highly diffused and is one of the ways put forward to maintain the level of competitiveness of companies based in France and to avoid relocation in cheap labor countries. Yet, in France, it is considered that the level of robotization is insufficient compared to Germany, for instance. One of the challenge is the high investment cost for buying robotic arms. In the recent years, it has led the development of “generic” and “flexible” (but rigid) robotic solution that can be produced in series. But their applicability to specific tasks is still challenging or too costly. With the development of 3D printing, we can imagine the development of a complete opposite strategy: a “task-specific” design of robots. Given a task that need to be performed by a deformable robot: we would optimize the shape of its structure to create the set of desired motion . A second important aspect is the reduction of the manufacturing cost: It is often anticipated that the cost of deformable robots will be low compared to classical rigid robotics. The robot could be built on one piece using rapid prototyping or 3D printers and be more adapted for collaborative work with operators. In this area, using soft materials are particularly convenient as they provide a mass/carried load ratio several orders higher than traditional robots, highly decreasing the kinetic energy and so increasing the motion speed allowed in presence of humans. Moreover, the technology allows more efficient and ergonomic wearable robotic devices, opening the options for exo-skeletons. This remains to be put in place, but it can open new perspectives in robotic applications. A last remarkable property of soft robots is their adaptability to fragile or tortuous environment. For some particular industry (chemistry, food industry...) this could also be an advantage compared to existing rigid solutions. For instance, the German company http://www.festo.com, key player in the industrial robots field, is experiencing with deformable trunk robot and we are working on their accurate control.

4.2. Personal and service robotics

The personal and service robotics are considered as an important source of economic expansion in the coming years. The potential applications are numerous and particularly include the challenge of finding robotic solutions for active and healthy aging at home. We plan to develop functional orthosis for which it is better not to have a rigid exoskeleton that is particularly not comfortable. These orthosis will be ideally personalized for each patient and built using rapid prototyping. On this topic, the place of our team will be to provide algorithms for controlling the robots. We will find some partners to build these robots that would fall in the category of “wearable robots”. With this thematic we also connect with a strong pole of excellence of the region on intelligent textile (see Up-Tex) and with the strategic plan of Inria (Improving Rehabilitation and Autonomy).

4.3. Entertainment industry and arts

Robots have a long history with entertainment and arts where animatronics have been used since years for cinematographic shootings, theater, amusement parc (Disney’s audio-animatronic) and performing arts. We believe that soft robots could be a good support for art. We are pursuing the collaboration with the artist Jonathan Pepe (see https://jonathan-pepe.com/Haruspices).

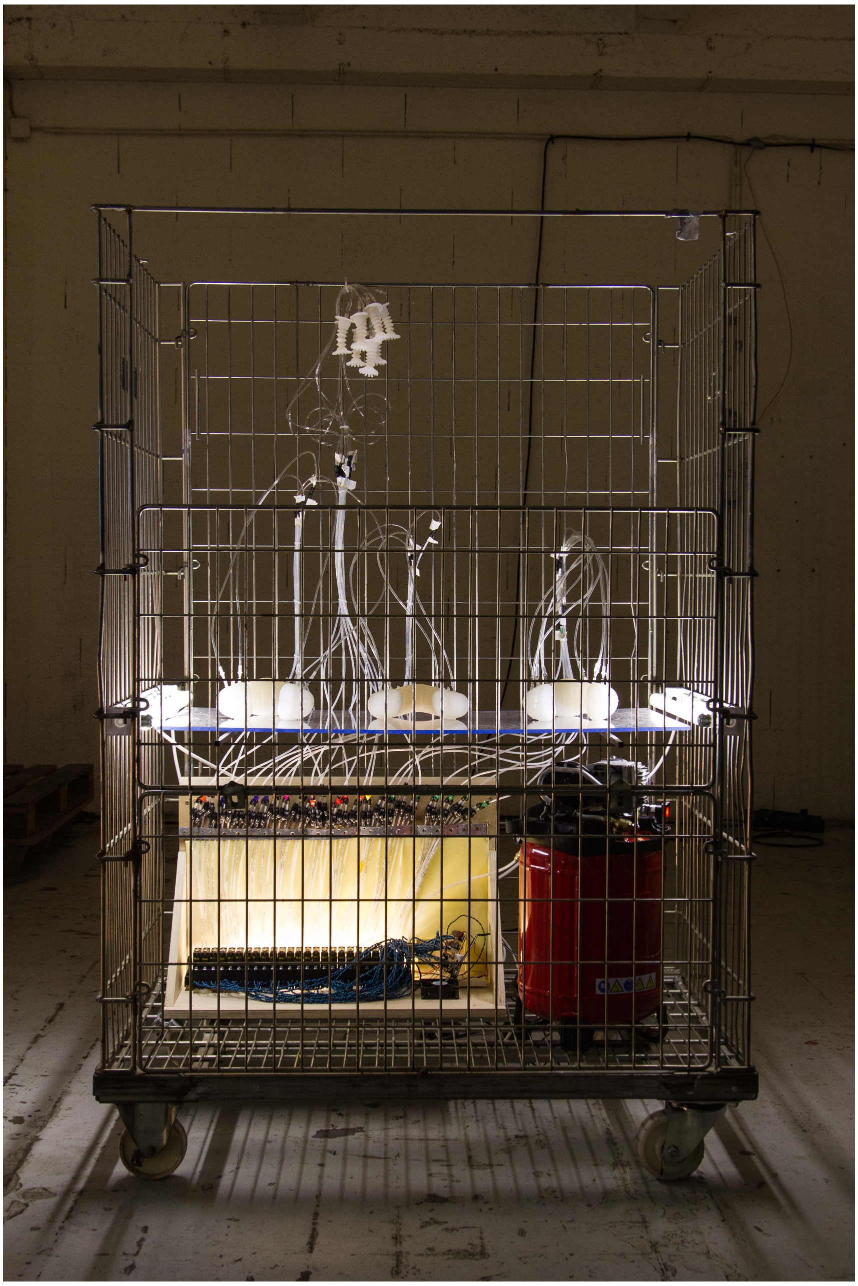

Figure 1. Exobiote project.

LINKS Project-Team

4. Application Domains

4.1. Linked Data Integration

There are many contexts in which integrating linked data is interesting. We advocate here one possible scenario, namely that of integrating business linked data to feed what is called Business Intelligence. The latter consists of a set of theories and methodologies that transform raw data into meaningful and useful information for business purposes (from Wikipedia). In the past decade, most of the enterprise data was proprietary, thus residing within the enterprise repository, along with the knowledge derived from that data. Today's' enterprises and businessmen need to face the problem of information explosion, due to the Internet's ability to rapidly convey large amounts of information throughout the world via end-user applications and tools. Although linked data collections exist by bridging the gap between enterprise data and external resources, they are not sufficient to support the various tasks of Business Intelligence. To make a concrete example, concepts in an enterprise repository need to be matched with concepts in Wikipedia and this can be done via pointers or equalities. However, more complex logical statements (i.e. mappings) need to be conceived to map a portion of a local database to a portion of an RDF graph, such as a subgraph in Wikipedia or in a social network, e.g. LinkedIn. Such mappings would then enrich the amount of knowledge shared within the enterprise and let more complex queries be evaluated. As an example, businessmen with the aid of business intelligence tools need to make complex sentimental analysis on the potential clients and for such a reason, such tools must be able to pose complex queries, that exploit the previous logical mappings to guide their analysis. Moreover, the external resources may be rapidly evolving thus leading to revisit the current state of business intelligence within the enterprise.

4.2. Data Cleaning

The second example of application of our proposal concerns scientists who want to quickly inspect relevant literature and datasets. In such a case, local knowledge that comes from a local repository of publications belonging to a research institute (e.g. HAL) need to be integrated with other Web-based repositories, such as DBLP, Google Scholar, ResearchGate and even Wikipedia. Indeed, the local repository may be incomplete or contain semantic ambiguities, such as mistaken or missing conference venues, mistaken long names for the publication venues and journals, missing explanation of research keywords, and opaque keywords. We envision a publication management system that exploits both links between database elements, namely pointers to external resources and logical links. The latter can be complex relationships between local portions of data and remote resources, encoded as schema mappings. There are different tasks that such a scenario could entail such as (i) cleaning the errors with links to correct data e.g. via mappings from HAL to DBLP for the publications errors, and via mappings from HAL to Wikipedia for opaque keywords, (ii) thoroughly enrich the list of publications of a given research institute, and (iii) support complex queries on the corrected data combined with logical mappings.

4.3. Real Time Complex Event Processing

Complex event processing serves for monitoring nested word streams in real time. Complex event streams are gaining popularity with social networks such as with Facebook and Twitter, and thus should be supported by distributed databases on the Web. Since this is not yet the case, there remains much space for future industrial transfer related to Links' second axis on dynamic linked data.

LOKI Team

4. Application Domains

4.1. Application Domains

Loki works on fundamental and technological aspects of Human-Computer Interaction that can be applied to diverse application domains.

Our 2018 research concerned desktop, touch-based, haptics, and BCI interfaces with notable applications to medicine (analysis of fine motor control for patients with Parkinson disease), digital humanities (interpretation of handwritten historical documents), as well as creativity support tools (production of illustrations, design of Digital Musical Instruments).

MAGNET Project-Team

4. Application Domains

4.1. Domain 1

Our main targeted applications are browsing, monitoring, recommending and mining in information networks. The learning tasks considered in the project such as node clustering, node and link classification and link prediction are likely to yield important improvements in these applications. Application domains cover social networks for cultural data and e-commerce, and biomedical informatics.

We also target applications related to decentralized learning and privacy preserving systems when users or devices are interconnected in large networks. We develop solutions based on urban and mobility data where privacy is a specific requirement.