Towards a digital service to help the elaboration, implementation and follow-up of study regulations at the University of Geneva - a hands-on experiment

Giovanna Di Marzo Serugendo[1,*], *Lamia* Friha[2,**], *Pierre-Yves* Burgi[2,***], *Julien* Döbeli[2,****], *Assane* Wade[1,†], *Maria Assunta* Cappelli[1,‡], *Anne-Françoise* Cutting-Decelle[1,§], *Mathieu* Vonlanthen[2,¶], *Natacha* Durand[3,‖], and *Alain* Hugentobler[2,**]

[1]Centre Universitaire d'Informatique, University of Geneva, Route de Drize 7, CH-1227 Carouge, Switzerland

[2]DISTIC, University of Geneva, 24, rue Général-Dufour, CH-1204 Geneva 11, Switzerland

[3]DIFE, University of Geneva, 24, rue Général-Dufour, CH-1204 Geneva 11, Switzerland

Abstract. Writing study regulations for academic study programs and automatically implementing those regulations is a difficult task that involves a variety of actors and requires at each step careful compliance to the constraints defined in the regulations. This paper describes: (1) the innovation process, taking place through a hands-on experiment, that lead the R&D Unit of the University of Geneva to provide a proposal for a digital service targeting the above purpose; (2) the actual design of such a digital service, providing various functionalities: (a) the elaboration of study regulations; (b) the elaboration of the corresponding study plan; (c) the actual implementation of the study plan through the information system. The digital service relies on two main ideas: (1) all study regulations and study plans are built from common atomic elements, that we call building blocks; (2) ensuring compliance to various constraints is achieved through a reasoning engine capturing the constraints defined over an ontology of the study regulations domain. Each year, for a given University, several study regulations, with various constraints and structure are defined or updated. They all need to be carefully crafted and implemented. The work presented in this paper has the potential to alleviate and improve this task for the various actors involved (students, program directors, lawyers, scientific committee members, study advisor, information systems managers, students' office).

[*]e-mail: Giovanna.Dimarzo@unige.ch
[**]e-mail: Lamia.Friha@unige.ch
[***]e-mail: pierre-yves.burgi@unige.ch
[****]e-mail: Julien.Dobeli@etu.unige.ch
[†]e-mail: Assane.Wade@unige.ch
[‡]e-mail: Maria.Cappelli@unige.ch
[§]e-mail: Anne-Francoise.cutting-decelle@unige.ch
[¶]e-mail:Mathieu.Vonlanthen@unige.ch
[‖]e-mail: Natacha.Durand@unige.ch
[**]e-mail: Alain.Hugentobler@unige.ch

1 Introduction

Study regulations are an important element that define the student journey and give the basis for a maximal student experience. The University of Geneva (Unige) is one of the signatories of the Bologna agreements (1999). These European agreements provide a framework to facilitate student mobility through a uniform study structure, assessment and evaluation:

- Bachelors, Masters and doctoral studies constitute the three-cycle higher education system;
- Mutual recognition of qualification while learning in another university (Erasmus);
- European Credit Transfer System (ECTS).

Study regulations frame study programs at all levels (Bachelors, Masters, PhD and Continuous education). They form the legal basis defining various elements from conditions of admission, to conditions for success or elimination, to the organisation of study plan itself. Establishing and enforcing a study regulation encompass several steps, such as: (1) the actual writing of the *study regulation* - a legal document that has to be coherently written, in line with University templates, and approved by the legal department of the University; (2) establishing a *study plan*, i.e. the actual choice of courses that constitute the program, in such a manner that it is in line with its corresponding study regulation; (3) implementing the study regulation within a *digital service compliant with the study regulation*. This means - among others - that for each student enrolled in the corresponding program, the digital service automatically provides the ECTS for successfully passed courses, identifies whether the student has reached a step in the program (e.g successfully passed the first year), and more generally verifies a series of conditions related to success, failure, or elimination. Such a service eases the work of the large number of actors involved in the process, such as: program directors, university lawyers, scientific committees, study advisor, students' office, as well as students themselves to control/check her own path/progression in the study program.

The University of Geneva hosts a large number of Faculties and Centres, each elaborating their own study plans with their own specificity. This variety provides a rich choice of programs to the students from which they can choose from. This richness also brings inconveniences and disadvantages when it comes to ensuring coherence and compliance to the study plan for 18'000 students. Indeed, while the programs are based on ECTS and follow the Bologna agreements, they still greatly vary in their structure and success conditions, such as - to name a few: enforcing or not steps in the study program; providing compulsory courses only or also optional ones; offering or not orientations or specialisations; requiring or not that some courses are grouped together in a block with its own success conditions; specifying the number of attempts to pass a course; specifying exceptional cases when extra attempts are allowed; etc. The variety is at the image of the University, which is varied in its disciplines and in its ways of teaching and assessment.

The challenge in such a setting is to provide a *homogeneous process and digital service* accommodating the *variety of cases, study plans and conditions*. The main idea at the basis of our proposal lies in: (1) the identification of *common atomic elements* among the study plans and regulations, that we call *building blocks*, that together can be built to form more elaborate *patterns* that constitute the various study plans and regulations; (2) the use of an ontology and reasoning rules defining constraints attached to study plans and regulations.

The work presented in this paper emerges from the activities of the newly established *Research and Development (R&D) Unit* of Unige. The R&D Unit gathers both IT experts and academics and provides various activities all aiming at developing innovative services for the University community. We described the whole framework and process that lead to the R&D Unit in a previous paper [1].

This paper describes how, led by the R&D Unit, an interdisciplinary team gathering academics, IT experts, legal experts, and students, shaped the design and roadmap for elaborating a digital service in a two-days hackathon. The roadmap addresses the three points above: (1) writing the study regulation; (2) elaborating the study plan; (3) implementing the study regulations for the enrolled students.

Section 2 discusses related works. Section 3 presents the innovation process in which this work took place. Section 4 summarises laws and study regulation at Unige. More technically, Section 5 explains the structure of a study regulation document, while Section 6 highlights its concepts and constraints. Section 7 identifies the building blocks of both study regulations documents and study plans. In addition to the above descriptions, at the end of the two-days hackathon, we were able to set up a roadmap and identify the various functionalities needed for a digital service supporting the whole concept discussed in this paper, see Section 8. Section 9 presents a preliminary ontology and constraints satisfaction using a reasoning tool. Section 10 displays mockups for some of the functionalities. Finally, Section 11 highlights the strategic positioning of this project within the current information systems portfolio of Unige, and Section 12 concludes the paper.

2 Related Works

Castro Benavides et al. [2] identified the domain of "Digital Transformation of High Education Institutions" as an emerging field of research. As part of their findings, they highlight the importance of a *digital strategy* and a *digital transformation team* that "should manage diverse cultural, behavioral, and operational forms of digital disruption". As for the *actors*, they stress the need for "multi-disciplinarity and multi-actoral character". Our approach is part of this trend as the Digital transformation at Unige is currently supervised by the Digital Transformation Office. The R&D unit addresses the more operational needs for managing at an operational level various types of digital disruptions. Participating to hackathons with a multi-disciplinary team, as described in this paper, falls under this approach.

Hackathons are essentially events where "learning and knowledge creation take place", such as: "know-how" (acquire new skills), "know-what" (what can be done and how), and "know-who" (being of aware of other people capabilities and skills) [3]. They provide opportunities for understanding issues, developing ideas to address them, while benefiting from an interdisciplinary setting. Hackathons are well suited to gather multidisciplinary teams and stakeholders.

Research in innovation and digitalisation in the academic sector takes various forms: smart campus digital infrastructures using 5G, sensors, Internet of Things (IoT) complemented with data analytics [4]; surveys and studies identifying students' needs in terms of digital services [5]; reviews of digital governance of education [6]; or the impact of digital technologies for learning [7].

Closer to our topic, maturity models for Higher Education Institutions (HEI) help evaluate HEI information systems under different aspects (process management, e-learning, etc.) [8], or students' engagement. Other research approaches tackling digital services for higher education institutions, also originating from the University of Geneva, propose to develop information systems and services on the basis of legal texts and their corresponding ontology [9].

Universities all face similar challenges and bring their specific answers built on innovation processes driving digital transformation. They can take the form of novel digital infrastructures or digital services. Ontologies and knowledge engineering anchored on legal texts are part of early proposals for building sound information systems.

3 Innovation process

Technology watch and exploration of innovative services are part of the R&D Unit activities. In Autumn 2021, the Digital Transformation Office of the University launched the Hackademia[1] hackathon whose purpose is to gather interdisciplinary teams of Unige members to brainstorm, design and potentially develop part or whole innovative ideas for the University. As part of the projects carried out during Hackademia, we can found (among others) a digital service for locating library books both within and outside the Unige libraries; a proposal for enforcing digital sustainability at Unige; or a proposal for a social network application.

The R&D Unit proposed a project on the issues of the study regulations, both to write the regulation text and to implement its constraints afterwards. After a textual description and pitch video to gather interest from participants, a face-to-face pre-event actually identified interested members for our project. We assembled a team of 10 people, representative of the various actors concerned by study regulations : information systems students, IT experts in study regulations implementation, IT experts with a large knowledge of various regulations within Unige, ontology and norm experts, and law experts.

3.1 Activities

The event itself took place during two days on November 26th and 27th 2021. During the event, we performed different activities:

- Understanding the process of defining and implementing a study regulation;
- Identifying the building blocks of both a study regulation and a study plan;
- Identifying the various functionalities to develop in order to obtain a complete service;
- Developing a preliminary ontology of study regulations and associated constraints;
- Developing a preliminary set of rules in a reasoning engine (e.g. TopBraid or SHACL);
- Providing mockups and use cases of three main sub-services: (1) a visual digital service to *write the study regulation*; (2) a visual digital service to *define the study plan* (and be compliant with the study regulation); (3) a visual digital service for students to help them *select their courses* (and be compliant with their study plan);
- Experimenting the notion of building blocks through rapid prototyping with Legos;
- Providing as output of the project: (1) a gitlab repository with the various works above [2]; (2) a rendering pitch for the whole Hackademia participants based on our Legos construction; and (3) a draft of the current paper written on a collaborative editing tool.

In order to clarify some concepts, we took as case study the regulations of the BSc in Information systems and services science, delivered by the Computer Science Center (Centre Universitaire d'Informatique (CUI)) of Unige. It is an interdisciplinary program that encompasses the characteristics of some other programs in other Faculties or Centers. Thanks to the knowledge of the IT experts in study programs that were part of our team, we can consider generalising our findings.

3.2 Findings

Through these activities, we were able to clarify some points and to establish the following findings:

[1] https://www.unige.ch/numerique/hackademia
[2] https://gitlab.unige.ch/hackathon2021/reglementsetudes (on-demand)

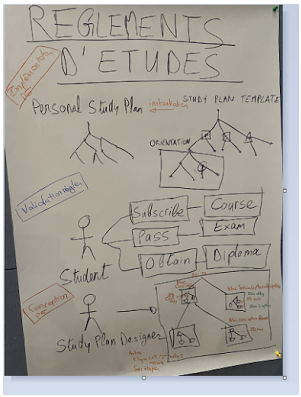
Activity	**Findings**	**Outputs**
Understanding the process of defining and implementing a study regulation	Process is made of various steps: (1) designing study regulation; (2) designing the study plan (compliant with the former); (3) implementing study plan (compliant with the design and the regulation); (4) providing additional services for various actors (Figure 1 (c))	Principles of law and regulation at Unige (Section 4); Structure of study regulation (Section 5)
Identifying the building blocks of both a study regulation and a study plan	Structure of study plan is part of the study regulations; Separate the issues of study regulation (text) from the ones of study plan (list of courses)	Building blocks for study regulation (Table 3); Building blocks for study plan (Table 4); Legos prototyping and pitch (Figure 1 (a))
Identifying the various functionalities to develop in order to obtain a complete service	Visual digital services are useful; Three services are needed to support the different steps of the process: (1) writing study regulations, (2) setting up study plans, and (3) defining own personalised program;	Mockups for the three services (Section 10); Roadmap (Section 8)
Developing a preliminary ontology of study regulations and associated constraints	Study regulations can be captured by constraints in the ontology (Table 2)	List of concepts defined in Protégé (Figure 3); Associated constraints defined with TopBraid (Figure 4) (Section 9)
Documentation	–	Gitlab repository; Initial pitch video; Final pitch with Legos; Preliminary draft of paper

Table 1: Concepts and Constraints of Study Regulation of the Bachelor in SISS

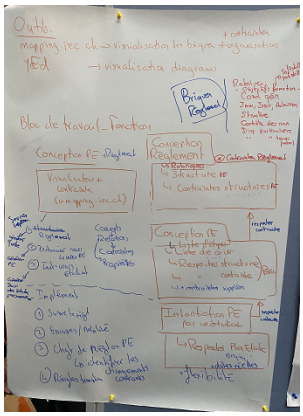
- The structure of study plan is part of the study regulations;
- We should separate the issues of the study regulation (text) from the ones of the establishment of the study plan (list of courses) and identify how the latter has to comply with the former;
- The concept of building blocks applies not only to the study plan but also to the study regulation. One of the building blocks of the study regulation is the structure of the study plan;
- An AI reasoning tool based on ontology and rules helps at all levels (from writing the study regulations to implementing a compliant digital service);
- Visual digital services help writing study regulations, setting up study plans, and for each students helps them setting up their own personalised program;
- How to go further and finance the development of the whole project is still to be debated.

Figure 1 shows some pictures taken during the Hackathon: (a) the Legos construction used during the pitch to explain our concept; (b) the initial brainstorming around the study regulation, and (c) the process of defining and implementing a study regulation and a study plan. Table 1 summarises the activities, the findings and the corresponding outputs reached during the Hackathon.

(a) Legos construction



(b) Preliminary brainstorm



(c) Process understanding

Figure 1: Hackathon activities

4 Law and Regulation for the University of Geneva

The University of Geneva is a public law institution under the supervision of the State Council.(art. 1, par. 1, LU[3]) The university organises itself, sets its priorities and methods of action and is responsible for its management within the framework of the guidelines, principles and rules stipulated by the University Law and in compliance with the provisions relevant federal law (art. 1, par. 2, LU). The University can supplement these provision by adopting the Statute of the University and the internal regulations (art. 1, par. 3, LU). The Statute defines the methods of exercising teaching, scientific, organisational, financial and accounting autonomy of universities while the internal regulations aim at regulating specific fields as we can see from the non-exhaustive list in the website https://www.unige.ch/universite/reglements/. The list encompasses some specific regulations, such as : a) Universtiy Staff Regulations; b) University Financial Regulations; c) Regulations relating to the election of members of the University Assembly and of the UPER Participatory Councils; d) Internal regulations relating to the admission to the University of Geneva of candidates who do not have a maturity (high school) certificate, etc.

Specifically, the Statute sets out the procedure for adopting the study regulations and the study plans. The *study regulations* define the conditions for student admission, the examination procedures and the conditions for obtaining each university degree under the basic training (art. 66, Statute[4]). Instead, *study plans* set out the details of the training and the allocation of credits (art. 67, Statute).

The wording of both study regulations and study plan raises the following issues because of some constraints to comply with, as follows:

1. The rules have to comply with structure and specific conditions (such as: specific format; competence to issue it; consistency with other rules; etc.);
2. The rules have to model the knowledge concerning the specific field;
3. The regulation and the resulting study plans have to be carried out;

[3]University Law of June 13, 2008 (LU - entered into force on March 17, 2009)
[4]Statute of the University (entered into force on July 28, 2011/last modification on July 1, 2021)

4. The study plans have to be instantiated for each student;
5. The study plans have to be implemented within a student information system;
6. Taking into account the regulations evolution over the years;
7. Taking into account the chronological criteria to solve the conflict among old and new regulations.

5 Structure of the Study Regulation

The study regulations follow the classic structure of the legal documents. The analysis of a real study regulation helps us to understand its structure. The study regulation of the Bachelor's degree in Information systems and services science of CUI (hereinafter: BSc SISS)[5] consists of 28 articles grouped in 8 sections (I to VIII) and represent different topics. For each topic there are one or more articles that regulate it. For instance, the General Conditions (section I) contains three articles (see below).

I. General conditions
II. Registration, registration, admission
III. Study structure
IV. Knowledge control
V. Special provisions
VI. Special provisions for part-time studies
VII. Suspension of courses and exceptional courses
VIII. Final provisions

1. Art.1 - Grades and Title
2. Art.2 - Purpose
3. Art.3 - Objectives

The articles are either rules of conduct which prescribe the observance of a conduct, or rules of sanctions which contain a sanction in case of non-compliance with the content of the rule. Then, the article consists of one or more paragraphs.

Article 3 of the study regulation states (translated from French):

1. Paragraph 1 - The purpose of the Bachelor is to enable the student to acquire fundamental knowledge in the chosen main discipline.
2. Paragraph 2 - The Bachelor diploma allows access to the second part of the basic training, such as University Master's studies consecutive, non-consecutive, or specialised, which may be subject to specific admission conditions.

6 Concepts and constraints concerning both Study Regulation and Study Plan

The rules within both Study Regulation and Study Plan contain concepts which are connected through relationships. These concepts represent the specific concepts of the academic domain. For example the concept of "Bachelor" represents all bachelor, and so on. Then, each concept has the properties which specify constraints that need to be met with respect to that concept. For example, the registration at the University of Geneva relies on three conditions: a) to meet the general Unige conditions for registration; b) to be enrolled at a program of the University of Geneva ; c) the enrollment (for the BSc SISS) can only happen in September (for the Autumn semester). Table 2 shows some examples about concepts and related constraints[6].

A full list of concepts and constraints has been identified during the hackathon and is available through our gitlab repository.

[5] Règlement d'études du Baccalaureat Universitaire en système d'information et science des services
[6] These concepts and constraints are taken from the Study Regulation of the Bachelor in SISS.

Concepts	Constraints
Registration (at Unige)	Must meet Unige general conditions for registration and Must be enrolled in a program at Unige and Registration (for the BSc SISS) only for the Autumn semester
Admission (to a program)	First registration or Prior registration at another Faculty or university that lasted one semester or Prior registration at another Faculty, or university with a successful year
Conditional Admission (to a program)	Prior registration at another Faculty, or university without a successful year or Former CUI students that left CUI without being eliminated

Table 2: Concepts and Constraints of Study Regulation of the BSc SISS

7 Building blocks

In order to address the challenge of providing a homogeneous process and a digital service able to accommodate the variety of study plans and study regulations at Unige, we made the following hypothesis: it is possible to identify and define the *common atomic elements* among the study plans. We call these atomic elements or a combination thereof *building blocks*. Taken together in various configurations, building blocks can form more elaborate *patterns* that will then constitute the various study plans and regulations. During the hackathon, part of our activities were driven by the identification of the atomic elements, the building blocks and the patterns. As part of our findings, we identified that not only a study plan but also the study regulation can be defined from building blocks (see Tables 3 and 4). We provide a name to each Building Block, describe its Features and the attached Constraints.

Building Blocks	Features	Constraints
Sections = {articles}	Topics to regulate	List of academic topics
Articles = {alinea}	Rules of conduct/sanctions	–
Alinea = {paragraphs}	Articulation of rules	–
General conditions (section)	Names of diploma / Objectives	–
Registration, enrolment, admission (section)	Registration requirements Admission requirements Special conditions	Constraints linked to general conditions: for registration at Unige, for enrolment to the program
Assessment (section)	Evaluation of knowledge Success Elimination Fraud	Credit number after the 1st semester >= 6 ECTS Credit number after a year >= 24 ECTS Credit number after the 6th semester >= 90 ECTS Semesters number to acquire 180 ECTS <= 10
Special provision (section)	Mobility	Must have acquired at least 60 ECTS
Structure of the Study Plan (section)	Organisation of the study, Scientific committee, Length	Total number of credits for program = 180 ECTS Number of credits for the various parts 6 semesters <= Length <= 10 semesters
Part-time studies (section)	Enrolment, length of studies, elimination	Credit number after the first year >= 18 ECTS Credit number after the 6th semester >= 60 ECTS Credit number after the 8th semester >= 90 ECTS Semesters number to acquire 180 ECTS <= 12
Suspension (section)	Suspending classes or courses	Deadlines
Final disposition (section)	Coming into force	Date

Table 3: Building blocks - Study Regulation (excerpt)

7.1 Study Regulation - Building blocks

A study regulation is made of a series of Sections, themselves formed of Articles, constituted of Alineas, made of Paragraphs (which are the smallest atomic element). Sections, Articles and Alineas are building blocks made of Paragraphs. Among the Sections building blocks we find the General conditions, Registration, enrolment and admissions, Assessment, etc. One important Section is the Structure of the Study Plan.

7.2 Study plan - Building blocks

Building Blocks	**Features**	**Constraints**
Individual course	Field	ECTS number
Courses block/module = {individual courses}	Mandatory courses; Closed options With free options	Block average mark; ECTS number for each block; Specific constraints for free options
Sub-Study plan	Specialisations Orientations Study Fields	Course block/module List of fields of study (e.g. Sociology, Archeology, Economy and management) ECTS number for each study field
Steps	1st part/2nd part 1st year, 2nd year, 3rd year	Respect the order of the steps Courses in the various steps

Table 4: Building blocks - Study Plan (excerpt)

Regarding the Study Plan, the building blocks are organised around the Individual courses that provide ECTS credits. Courses can be grouped together to form blocks of courses. A study plan can itself be composed of a (sub-)study plan, particularly in the case of specialisations or orientations. Finally, a study plan is made of steps, usually organised around years of study - one year of study being constituted of two semesters.

8 Towards a digital service: functionalities and roadmap

During the hackathon, in addition to identifiying the building blocks and their constraints, we drafted the architecture of a digital service, leveraging ontologies and reasoning, that could implement study plans and regulations. We also listed useful functionalities that such a service would provide. As a result, we designed our digital service around the following three components (Figure 2):

1. *Engineering Knowledge and Artificial Intelligence:* The reasoning engine relies on (reasoning) *rules* (representing the *constraints* of the Study Regulations and the Study Plan) and it runs on an ontology encompassing the knowledge (concepts) that is in the Study Regulations. It relies on existing tools such as Protégé[7] or TopBraid[8].

2. *Three interactive and visual tools* for defining: (1) the Study Regulations; (2) the Study Plans; and (3) the Personalised Student Program (student's own instantiation of the study plan).

[7] https://protege.stanford.edu/
[8] https://www.w3.org/2001/sw/wiki/TopBraid

3. *A series of additional functionalities:* (1) automatically generating the study regulation text, from the definition provided through the corresponding interactive visual tool; (2) automatically generating the study plan, from the definition provided through the corresponding interactive visual tool; (3) a student monitoring tool that helps assessing the individual progression of the student throughout her studies; (4) a diagnostic tool providing individual transcript information as well as success or failure information.

Figure 2 represents the whole set of services to develop to reach our goal of developing a digital service for the elaboration, implementation and follow-up of study regulations at Unige. As part of further activities of the R&D Unit, we will start developing prototypes of the various functionalities above through students internships, or BSc/MSc students' projects.

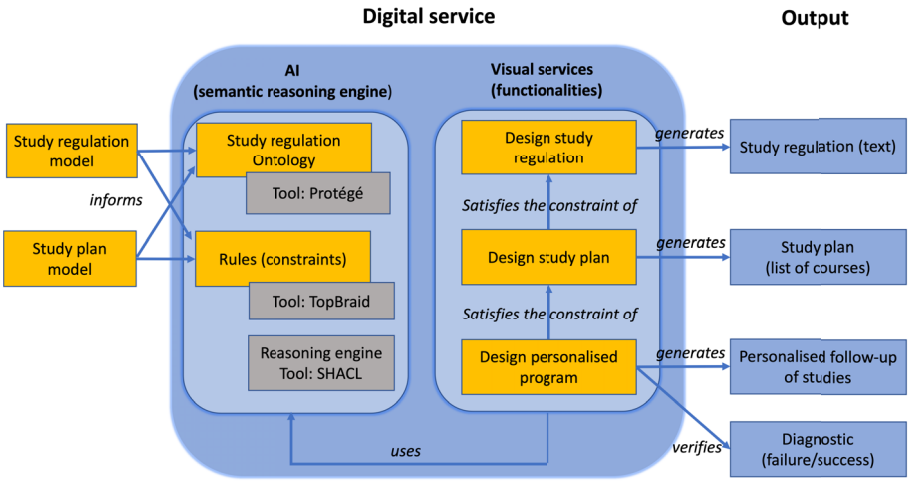


Figure 2: Functionalities / Roadmap

9 Ontology

As mentioned above, a core idea behind the digital service we envisage is the use of a reasoning engine relying on an ontology and a set of rules (i.e. the constraints identified in relation with the study plan and study regulation). The reasoning engine verifies the compliance of the various instances with the rules.

9.1 Concepts

We model the concepts through Protegé[9] software. It is a free, open-source editor and framework for building OWL ontologies, that uses the Manchester OWL syntax [10]. We organise the concepts into classes and sub-classes (Figure 3). A class is a collection of objects or individuals while a subclass inherits from another class.

We have a class hierarchy where "Bachelor"; "Certificat"; "Doctorat"; "Master" are sub-classes of "Diplome". Therefore, a student of the University of Geneva can obtain a Bachelor, or Master, or Certificate, or PhD diploma. The same applies to other classes and sub-classes within the hierarchy.

[9] https://protege.stanford.edu/

9.2 Constraints

To model constraints, we use Shapes Constraint Language (SHACL)[10] based on the ontology. SHACL is a World Wide Web Consortium (W3C) standard for describing structural constraints on data graphs and validating graph-based data against a set of conditions. It uses the RDF (Resource Definition Framework) vocabulary for defining data constraints on RDF graphs[11]. We model the constraints with the TopBraid sofware, which supports SHACL.

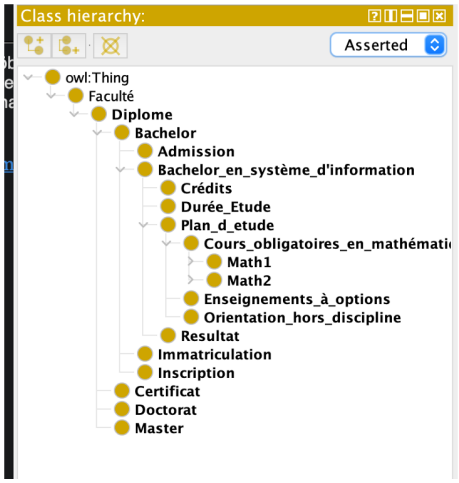


Figure 3: Ontology

Figure 4 shows the property constraints concerning the shape node : "Regulation" (ReglementEtudes in French). Property shapes "specify constraints that need to be met with respect to nodes that can be reached from the focus node either by directly following a given property (specified as an IRI) or any other SHACL property path"[12].

The node shape ("Regulation") declares two constraints with the property *sh:property*, and each of these is backed by a property shape. These property shapes declare additional constraints using parameters such as *sh:datatype* and *sh:maxCount*. Regarding Figure 4, the first property specifies the constraints that the maximum number of semesters of studies is 10; the second property specifies that the minimum number of credits to finish the studies is 180 ECTS.

10 Use Cases and Mockups

As part of the brainstorming process and to understand and highlight the concepts behind the idea of an interactive visual tool, we provided various use cases and three preliminary mockups for the three interactive visual tools identified in Figure 2.

We propose a scenario about how our system works for the different steps concerning the process of establishing the Study Regulation and the Study Plan.

[10] https://www.topquadrant.com/technology/shacl/
[11] https://www.w3.org/TR/shacl/
[12] https://www.w3.org/TR/shacl/dfn-node

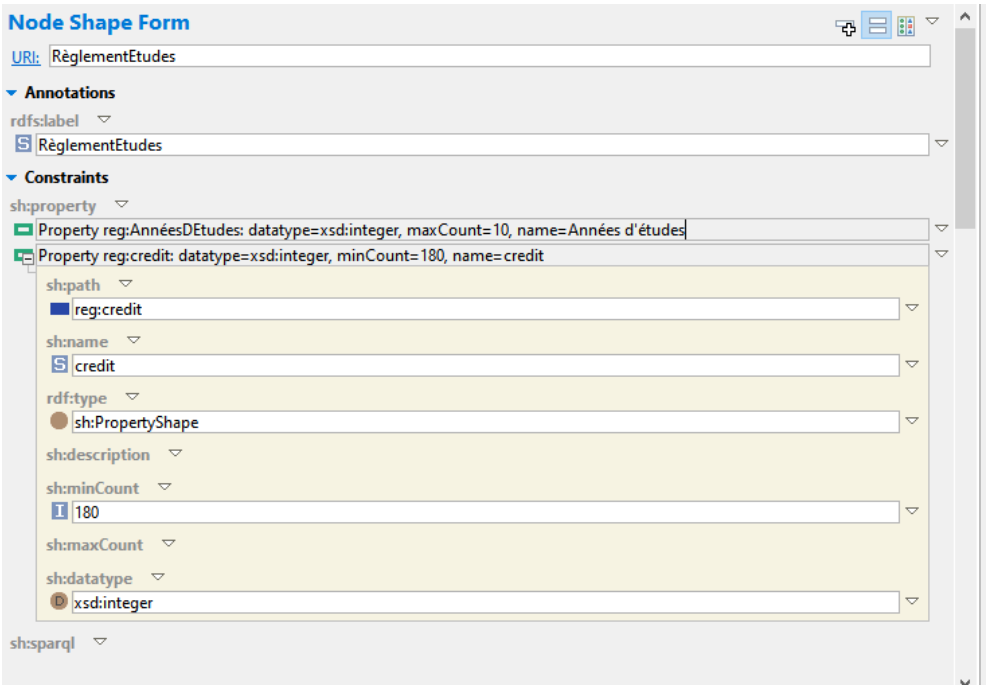


Figure 4: Reasoning - expressing the constraints as rules over the ontology

10.1 Use Case 1: Designing the Study Regulation

In this use case, program managers and lawyers design study regulation for study programs. Their tasks, through the service we envisage consist in filling up the various sections and designing the structure of the study plan. The System (i.e. the digital service we envisage) will ensure the consistency of the study regulations and automatically generates the written version of the study regulation text:

Actors	Program directors and Lawyers
Tasks	Complete the sections; Add the constraints; Propose a Study Plan structure
Lawyer task	Adaptation to internal legal issues
System	Consistency check of the regulations; Automatic writing of the text.

Visual tool to assist in the development of study regulations Figure 5 shows a mockup of the interactive visual tool for designing the study regulations. It contains the mandatory sections in pink (identified as Building Blocks, see Table 3). In blue, we find the Structure of the Study Plan ("Plan d'études (PE)"). The red wheels stand for constraints to define, attached to the various sections. The example follows the current study regulation of the BSc SISS.

10.2 Use Case 2: Designing the Study Plan

In this use case, the Scientific Committee, study advisors and IS managers define the study plan, i.e. identify the actual list of courses with attached credits that will be part of the study plan:

Visual tool to assist in the development of study plans: Figure 6 (left) shows a mockup of the interactive visual tool for designing the study plan. Leveraging the structure of the

Actors	Scientific Committee; Study Advisor; IS managers
Tasks	Selection of courses in accordance with the Study Plan
System	Automatically check that the study plan abides to the constraints defined in the Regulations

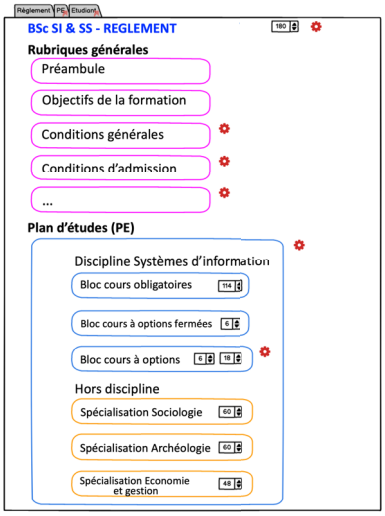


Figure 5: Mockup - Study Regulation

Study Plan defined previously through Figure 5, the actors now have to select actual courses. The service will help in checking the compliance with the study regulation, among others the number of credits, the steps (if any), the various blocks of courses. Figure 6 (left) shows the beginning of the process, where only the mandatory block of course starts to being filled. The blue boxes stand for blocks of courses relating to the information systems discipline (compulsory, closed or open options). The orange boxes stand for sub-study plans from another discipline, for a specialisation in Sociology, Archeology or Economy and Management. The red wheels serve to define specific constraints of the Study Plan (see Table 4).

10.3 Use Case 3: Instantiating a personalised Study Plan

In this use case, the student together with her study advisor identifies the list of courses (compulsory or optional) in a manner compliant with the Study Plan:

Actors	Students and Study Advisor
Tasks	Selection of courses in accordance with the Study Plan
System	Automatic check of the constraints that are in the Regulations

Visual tool to assist in the development of a personalised study program: Figure 6 (right) shows a mockup of the interactive visual tool for students to instantiate their own personal study program. Leveraging the study plan defined in Use case 2, the actors now have to select courses to attend. In green, the service shows the actual progression of the student in her studies, for instance here the student has selected a mandatory course that will serve to reach 3 ECTS out of 180 in her global study plan, and out of 114 from her information systems discipline. The blue squares stand for information regarding the constraints (provide the list of constraints defined in the previous use cases).

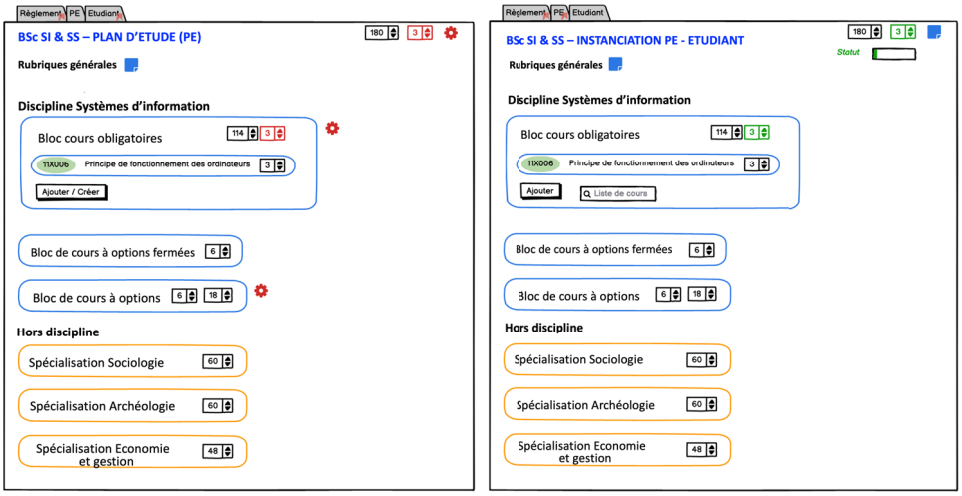


Figure 6: Mockup - Study Plan (left) and Student Personalised Program (right)

10.4 Use Case 4: Service implementation/Information system implementation

This use case represents the actual implementation of the individual study plan, the generation of the transcript as well as the success or elimination diagnostic. It needs to be compliant with the various constraints and choices defined in the previous use cases:

Actors	Implementation managers (IS managers)
Tasks	Verification; Validation; Management of special cases
System	Diagnosis of success and failure; Course management; Study monitoring

11 Towards synergy with the eCampus 2021-2025 Bill ("Projet de Loi (PL12767)")

The objectives of the eCampus bill (PL12767) are articulated around a strategic vision of the Unige oriented towards excellence in operational services related to the student's career path, in an open environment that is conducive to innovation and collaboration. More specifically, this PL aims at:

1. Overcoming the obsolescence of the current information system, which risks crippling the institution's operations;
2. Guaranteeing students training and experience that will enable them to develop their digital skills, to promote their professional integration and, for continuing education students, to adjust their skills to the rapidly changing world of work;
3. Responding to the objective of an inclusive higher education;
4. Being part of the Unige's more general strategy of digital transformation, in which it is already investing a great deal, a challenge for all major institutions;
5. Participating actively in the digital transformation of society.

From this list of objectives, we can conclude that the project we describe in this article is perfectly aligned with this PL, and should become an integral part of it in terms of outcomes and financing.

12 Conclusion

This paper reports on a digital innovation process - led by the newly established Research and Development (R&D) Unit of the University of Geneva - that took place during a two-days hackathon (Hackademia), which we believe contributed greatly to the creativity of the results obtained in a very short time frame. This was due to the ability to rely on a multi-disciplinary team of academics, IT experts, lawyers and students. Such a variety of profiles and competencies has led to (1) a powerful knowledge representation and reasoning tool that captures regulations and constraints in the form of rules, and (2) a series of visual tools providing abstract and high-level views of the study regulation and study plans, allowing users to easily combine the necessary blocks and items useful to further generate the study regulation. The visual tools ensure the satisfaction of the constraints and warn the user when two blocks or items are conflicting, or constraints are violated. The solution designed during the hackathon further aims at providing a substantial contribution to the eCampus program of Unige. Future work involves developing the various functionalities identified and so providing a prototype and proof-of-concept. This will be completed with an evaluation activity of the prototype with the various actors concerned (students, lawyers, study advisors, students' office, IS manager, etc.). If the hackathon is only a form of design methodology, it has the advantage of accelerating the ideation process, which this document can attest to through the relevance of the complex notions that have emerged.

References

[1] G. Di Marzo Serugendo, L. Friha, *Digital innovation process in the academic sector - The case of the University of Geneva*, in *International Conference on Exploring Service Science (IESS 2.1)* (ITM Web Conf., 2021), Vol. 38, p. 03004

[2] L.M. Castro Benavides, J.A. Tamayo Arias, M.D. Arango Serna, J.W. Branch Bedoya, D. Burgos, *Digital Transformation in Higher Education Institutions: A Systematic Literature Review*, Sensors **20**, 3291 (2008)

[3] U. Matos, J. Corbett, *Knowledge Creation in Open Data Hackathons: Findings From Canada and Brazil*, Tech. rep., Université Laval, Canada (2021)

[4] R. Jurva, M. Matinmikko-Blue, V. Niemelä, S. Nenonen, *Architecture and operational model for smart campus digital infrastructure*, Wireless Personal Communications **113**, 1437–1454 (2020)

[5] A. Thoring, D. Rudolph, R. Vogl, *Digitalization of higher education from a student's point of view*, in *EUNIS 2017–Shaping the Digital Future of Universities* (2017), pp. 279–288

[6] P. Landri, *Digital governance of education: Technology, standards and Europeanization of education. Bloomsbury Publishing.* (Bloomsbury Publishing, London, 2018)

[7] A. Saykili, *Higher education in the digital age: The impact of digital connective technologies*, Educational Technology and Online Learning **2**, 1 (2019)

[8] J.V. Carvalho, R.H. Pereira, Rocha, *A comparative study on maturity models for information systems in higher education institutions*, in *The 2018 International Conference on Digital Science* (Springer, Cham, 2018), pp. 150–158

[9] A. Khadraoui, L. Michel, D. Solomos, S. Turki, *Ingénierie des systèmes d'information pour l'e-gouvernement : stratégie, concepts et bases*, La revue électronique des technologies de l'information e-TI **ISSN 1114-8802** (2005)

[10] M.A. Musen, *The protégé project: a look back and a look forward*, AI matters **1**, 4 (2015)