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Bachelor's Thesis

Student Consulting Organizations

A Domain Ontology

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Abstract

This work develops a domain ontology for Student Consulting Organizations (SCOs). The model declares the domain knowledge and defines its vocabulary. It contains the information necessary to establish or run such an SCO in a university context. Additionally it allows for optimization in existing organizations and contributes to cooperation between SCOs by organizing the existing knowledge. It maximizes the use of components (e.g. vocabulary, relation, classes) from established ontologies like FIBO, GFO, and GIST to link the domain knowledge into a bigger context. The main resource of the developed ontology are SCOs from Germany, but the concepts can be transferred and made applicable in a wider area.

Abbreviations and Formatting

- Proper nouns and acronyms are capitalized and written in bold and italic to signify something important (e.g. their first occurrence): ***Hamburg, NASA***.
- Hyperlinks are embedded and clickable in the PDF. They are marked with an arrow: \hookrightarrow Hyperlink
- Everything related to the ontology implementation, such as references to classes or relations, is written as **typewriter text**.
- Relations are written in camelCase: `subclassOf`
- Classes are bold, capitalized, and use Snake_Case: **Human_Being**

Ideenspeicher

Metadata Problems within the Domain How I dealt with specific things Taxonomy Tree Shared vocabulary vs Domain specific vocabulary (DOAP Description of a Project (<https://github.com/ewilderj/doap/wiki>)) discussion: legal person vs natural person Autonomous Agent/Actor -> (Natural) Person + Organization Members and Non-Members

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1 Introduction

1.1 Motivation

I have been working for and have been in contact with many different Student Consulting Organizations (SCO) all over Germany since 2010. Each one is organized slightly differently than the next, uses different vocabulary and each has their individual culture. However, they all share the idea of teaching consulting and project work to their members. Since they aim for the same goal, they are very similar.

And even though Germany has two different umbrella organizations for SCOs¹ with more than 60 member organizations, to my knowledge there hasn't yet been any effort to collect and compose the existing domain knowledge in a usable form. Even though this can be considered important task for the following reasons:

Since all staff of SCOs are students, their consulting career is inherently linked to their university career. This link is twofold:

1. The career at the SCO is time-bound to the duration of the education. A bachelor's degree in Germany averages 7,5-7,6 semesters and a master's degree 4,2-4,5 semesters, which adds up to a total of 11,7-12,1 semesters or ca. six years.[3] This frames the available time for the transfer of the domain knowledge.²
2. The career at the SCO is in parallel to the curriculum. From my experience, freshmen that decide to join student organizations typically do so at the beginning of their second or third semester, after they got acclimated with the workload of their classes. Since students usually work for an SCO in parallel to their university education – and the focus is typically on the education –, they have to manage their time accordingly. Furthermore, students working with SCOs may have other interests that compete with the same time budget.

The reasons above reduce the available time for knowledge transfer and persistence and make these problems harder. Many SCOs have worked on and developed solutions to help with this problem. Some of them are informal, some formal in nature. One particular SCO I worked with, *Hanseatic Consulting*, used process methodology to document a lot of the domain knowledge.

¹ ↪ *Bundesverband Deutscher Studentischer Unternehmensberatungen (BDSU)* , ↪ *Junior Consultant Network (JCN)*

² There are also PhD students working with SCOs, but they can be considered outliers and are atypical for students participating in SCOs.

However, the majority of available domain documents are highly individualized and miss the necessary level of abstraction to make them directly applicable to other SCOs. Therefore I try to develop a more general model.

1.2 Goal and Scope of the Work

The goal of this work is the description of an abstract SCO. It aims to extract the available implicit expert knowledge and transform it into explicit knowledge by using an ontology as its vehicle. This ontology defines common classes, roles, functions, and processes within such an organization. It uses the vocabulary of the domain and specifies it where necessary. Additionally it provides terminology and background knowledge of the domain where it is sensible.

1.3 Deliverables

The output of this work are two documents:

- This thesis as a documentation and explanation of the ontology development process including but not limited to: methodology, background information, decisions in regards to the ontology, etc.
- The ontology document as a representation of the domain knowledge.

1.4 Out of Scope

This work is not a thesaurus and not a documentation about a specific Student Consulting Organization.

The ontology will not include the individual project process, since projects differ vastly between each other and more general ontologies and frameworks for projects already exists.

Diagram
of
org/individual
process

1.5 Outlook

The main motivation of this work is documenting the domain knowledge and making it available to interested parties, such as the umbrella organizations, SCOs, or students. Furthermore: Creating an computer-readable ontology with this goal in mind will make it easier to create niche software projects that support and advance the idea of SCOs.

One particular use case in the intersection between knowledge management and software projects, is the creation of a tool that helps with founding new SCOs at universities where no SCO currently exists. Creating an organization without guidance is a daunting task;

having a repository available, that structures and describes the elemental components of such an organization, can be a great help.

2 Ontologies

This section gives a short overview about ontologies and develops the argument, why an ontology is useful in the given context.

- Open World and Unique Name assumption und Bedeutung für die Ontologie: jede SCO legt Schwerpunkte anders UND jede Beratung hat dieselben Funktionen, aber andere Namen dafür - Auswahl der Top-Level-Ontologie und der Upper-Domain-Ontologie Auswahlkriterien

Ontologies as Domain Models: Reason for using an ontology in the given context wiki: "Ensuring the ontology is current with domain knowledge and term use"

2.1 Definition: Ontology

Ontologies are a way of organizing knowledge. They make it possible to structure a domain in a way, that it can be used in a technical project

"In computer science, an ontology is a conceptual model specified using some ontology language; this idea was succinctly captured by Gruber in his definition of an ontology as "an explicit specification of a conceptual- isation"[2]

2.2 Types of Ontologies

2.2.1 Upper Ontology

(GFO)

2.2.2 Domain Ontology

2.2.3 Content Ontology

<http://ontologydesignpatterns.org/wiki/Category:ContentOP>

Philosophic discussion about the best way to achieve things
Why ontologies are useful – especially in a SCO env: high fluctuation, ontologies can pin knowledge

2.3 Ontology Representation

Model-theoretical Languages, Graph-Based Systems, Frame-Based Systems, Hybrid Systems (see GFO document)

Format: <http://www.ksl.stanford.edu/knowledge-sharing/kif/>

An ontology allows the domain knowledge to grow and to be flexible. As already stated above, the core concepts of different SCOs are very similar. However, different SCOs may use different vocabulary to describe the same thing, object or process. This creates a requirement for a knowledge system: it has to be extensible and mutable.

-> OWL

3 Student Consulting Organizations: Meta Discussion

3.1 Methodology for the Development of the Ontology

The primary goal of this work is the creation of a particular domain ontology. To achieve this goal, I use the methodology that is proposed in the documentation of the ontology editor \hookrightarrow *Protégé* – built and maintained by ontology researchers of *Stanford University* – as a starting point.[6]

It involves the following steps:

- (1) Determine the domain and scope of the ontology,
- (2) consider reusing existing ontologies,
- (3) enumerate important terms in the ontology,
- (4) define the classes and the class hierarchy,
- (5) define the properties of classes-slots,
- (6) define the facets of the slots, and
- (7) create instances.[7]

Steps 1 and 2 are performed during the *Research Phase*. Steps 3 to 6 during the *Analysis and Synthesis Phase*. Both are discussed in more detail below. Step 7 is omitted.

explain

3.1.1 Research Phase

To determine the domain and scope of the ontology (1) the documentation suggests starting with answering the ontologies *Competency Questions*. [7, Section 3, Step 1] Since they can be considered part of the ontology, see section 4.1.

To help answering the aforementioned questions, find a starting point for data collection, and identify existing ontologies (2), I take an intuitive first look at SCOs and their driving factor:

The Idea of Student Consulting Organizations

Selecting a career is a very difficult and important choice in a young persons life. University education is closely linked to this choice and entering a specific field often requires a specific degree (e.g. to become a lawyer, a student has to pass the bar exam).

Most universities have recognized this and have set up dedicated offices to offer career

advice to their students. They not only help picking a fitting course of studies at the beginning of a university career, but also help the students to aim for a fitting job.

Doing an internship with a company working in the field the student is interested in, is a widespread recommendation. It allows for a glimpse into the profession as well as gathering work experience.

SCOs offer another option to further investigate a career in business consulting, as well as learning the associated skills. They offer the students a way to learn about concept like project based work – the *modus operandi* of consulting companies –, e.g. project planning and management, as well as structuring and presentation of information.

SCOs are connected to other knowledge domains in various ways: They are a type of organization and thus are driven by people and processes. They do consulting work, which is project based. And, as already pointed out, the main goal is a correct and robust representation of the domain as an ontology. This defines the starting point for the scope of the research:

- Theory of description logic and ontologies, e.g. modeling of roles and processes.
- Previously developed ontologies in related domains, e.g. consulting, project management, educational organizations.
- General ontologies, e.g. *General Formal Ontology (GFO)*, *gist*.
- Available domain knowledge, e.g. process documentation of *Hanseatic Consulting (HC)* and *Campus Inform (CI)*.¹
- Personal expert domain knowledge and peer-review by other SCO members.

3.1.2 Analysis and Synthesis Phase

It requires proper organization and interpretation of the collected data and/or information and converting it to knowledge.

This makes it possible to create a loose word cloud as a starting point for the class hierarchy. This word cloud is supplemented by expert knowledge. During this processes the available implicit (or tacit) knowledge is converted into explicit knowledge.

The second step is the organization and structuring of the word cloud by transferring the information into the target format OWL. This creates a skeleton class hierarchy containing high-level classes and trivial sub-classes (e.g. high-level class **Process** and all the identified processes as trivial sub-classes).

Since this ontology is a development from scratch, an iterative approach for its development is selected. The steps are as follows:

First draft word cloud in den Anhang

¹Two SCOs I have worked with the longest.

The third, most important and iterative/looping step is the refinement of this document. During this phase all classes are developed and documented. This includes discussion of related work and linking the classes into available ontologies. Relations between the classes are added and verified for logical correctness.

The second step is the analysis of this information. And the third step is the synthesis of the knowledge into the deliverables: this thesis and the ontology as OWL file.

3.2 Related Work

Ontologies are knowledge representers SCO have overlap in two directions: project management and consulting PM is a very wide topic that basically has unlimited amount of detail -> needs abstraction Part of PM are in itself complex topics: time, problem analysis, ...

FIBO FOAF DOAP schema

3.3 Classification of the Ontology

3.3.1 Selection of the Top-Level-Ontology

- BFO - DOLCE - GFO - GIST

GFO: process, roles and time

3.3.2 Selection of the Upper-Domain-Ontology

- OWL-S - SUMO

3.4 Decisions and Limitations

- keep it as simple as possible (e. g. *contract* and *contract document* can be considered two distinct things, but this distinction is not important for the domain knowledge – maybe add a relation "has document"?)
- Description of a Business and Connection to SCO

Minimal conceptual modeling opm principle (Model-based system engineering, page 77): minimal methodology is best

Ordentlich aufschreiben

3.4.1 Processes

- processes: process ontologies and modeling/process specific languages (PSL): OPM (ISO 19450), Workflow Management Coalition

Aussage:

1. Warum überhaupt Prozesse?
2. Prozess-Denken und Ontologien können voneinander profitieren
3. Welche Prozesse gibt es
4. Es gibt zwei Kernprozesse
5. Die Kernprozesse laufen auf versch Ebenen ab (Org/Individuell)

Organizations are entities that have a particular purpose.

Looking at an organization from a process perspective reveals all the necessary steps to achieve its goal.

It allows to create a visual representation of all workflows that make up the organization (\leftrightarrow Flowchart)

If the processes are combined with goals and measurements, they can be a powerful tool for optimization.

This is particularly useful while developing an ontology, since creating and writing down processes require a similar thought process.

This means that process documentation is a very good source for ontology engineers.

The general idea of SCOs involves finding students that are interested in the student consulting idea and want to work with the SCO. After joining, the new members receive training by the organization. Furthermore they have the opportunity to professionalize their skills by working on consulting projects for external clients.

Therefore, looking at SCOs from a process perspective, they can be boiled down to two core processes: 1. The *Human Resource Process (HRP)* and 2. the *Project Process (PP)*.

These two processes are interlinked with each other. The *HRP* focuses on the recruitment and training of interested students that can and want to use the opportunities the organization provides. The *PP* documents the way the organization handles all projects from start to finish.

Each of the processes have two important and distinct aspects. On the one hand, they can be viewed as an individual instance for one of the main protagonists of the process. On the other, they can be viewed as the process of the organization. Example:

- The main protagonist of the HRP is one individual student. This individual student is following one instance of the HRP; this instance does not have to be identical with the instance of a second individual student, nor with the planned process of the organization. Both individuals might do different educational courses, hold different business ranks within the organization, or might be at different points in time of their career.
- The SCO itself has a HRP. It structures important aspects of the organization such as the career path. It describes the complete path from recruitment of a new member to offboarding at the end of the membership. Most importantly this process describes the plan on an abstract level and knowingly omits parts of the real world process that are not important to the organization.

This distinction holds for the HRP as well as the PP.

Additionally they have various amount of support processes that help facilitate the two core processes.

- Prozesse sind eine Beschreibung von Schritten - Prozesse laufen nicht sequentiell - Prozesse werden unterteilt in ProzessParts

Looking at the smallest unit of a process

3.4.2 Keeping Things Simple

Polysemy Paper[1]

Example: A contract is a document that captures a business agreement. The word "contract" can refer to the immaterial agreement between the parties, but it can also refer to the document itself. Depending on the use case of the ontology it might be useful to separate these two things.

However, in this ontology the goal is to keep it as simple as possible, since the potential users of this ontology are not necessarily experts.

3.4.3 Content Completeness Problem

https://en.wikipedia.org/wiki/Content_completeness_problem As is true for any domain ontology[NEEDED], the content completeness problem exists for this ontology as well.

3.4.4 Organizational vs Project Context

The project context can be considered dynamic and the organizational context static.

3.4.5 Time

Implement time abstract -> only needed for processes before/after no absolute time

3.4.6 Persons, Groups, and Organizations and the Degree of Formalization

- actors

This ontology is describing a social construct. The whole domain is driven by processes that involve people. This requires an adequate class representation of human individuals and their aggregation. Furthermore aggregation can occur in different degrees of formalization within this ontology (e.g. informal meeting of SCO members vs. meeting of the member council). Since this is not a domain specific phenomenon, it is sensible to use this observation and consider how existing and related ontologies solve the problem.

FOAF offers a very basic solution and description: The root class **Agent**² is referred to as the class of “things that do stuff”. It is sub-classed by **Group**³, **Organization**⁴, and **Person**⁵.

Label/Link
see: Re-
lated
Work

Similarly or identically named classes with a more complex description can be found in **FIBO**: The class **Person** represents individual humans. This class is disjoint with the **Organization**⁶, which is defined as *“a unique framework of authority within which a person or persons act, or are designated to act, towards some purpose, such as to meet a need or pursue collective goals on a continuing basis”*

Members and Non-Members SCOs themselves are an aggregation of individuals working towards a common goal. Their clients can be businesses – which, by German law, are represented by individuals –, but also individuals.

Often times they are even a registered association and require a *formal* membership to participate.

Thus, a distinction can be made between members and non-members.

3.4.7 Ranks and Roles

Ranks as Social Roles[5, p. 67]

As already shown by *Loebe* [4, p. 130], the concepts and ideas about roles have been heavily discussed in the ontology community and literature. Since SCOs are a social

²foaf:Agent, rdfs:comment: "An agent (eg. person, group, software or physical artifact)."

³foaf:Group, rdfs:comment: "A class of agents."

⁴foaf:Organization, rdfs:comment: "An organization."

⁵foaf:Person, rdfs:comment: "A person."

⁶fibo-fnd-org-org:Organization

construct and are defined by the people of the organization, roles also are instrumental to this ontology. It is therefore important to clearly define the term *roles* and explain its use:

In this ontology, there are two types of classes where the thought of a role arises. The first are the organizational ranks that are similar to career titles. A person receives the lowest available rank at the begin of their career with the SCO. During the time with the organization a person is awarded higher ranks based on some organizational system (e. g. a merit-based system).

The second is with organizational functions. An example for this is the CEO of the organization. A CEO has defined responsibilities and has to fulfill certain tasks. With SCOs typically any member can become CEO by being elected. The elected member still retains the aforementioned rank.

is that a thing?!

A person (is a)/(has role?) Consultant? A person (is a) Project Lead

On the other hand there are roles people take on within the organization. For SCOs these roles can be divided into two distinct groups based on their context: project roles and organizational roles.

For example, a **Consultant** (rank within the organization) can work as a **Project Member** (role in the project), while being the CEO (role in the organization) of the organization.

Note: The model says nothing about social status and political power that typically come with ranks and roles within an organization (e. g. a person that holds a rank or role for a long time may still have organizational power after stepping down: ↪Éminence grise).

3.4.8 Consulting Topics

The main goal of consulting companies is in their name: consulting. They are a source of expertise and knowledge and can be employed as an option to solve a difficult problem at hand. The problem space of consulting companies is vast; examples are: Digitization, Human Resources, Knowledge Management, Market Research, Marketing, Corporate Strategy, etc. These topics are obviously part of the consulting domain. However, they are deliberately omitted, since their exploration would exceed the scope of the work.

3.4.9 IT and Communication Systems

IT systems are an essential part of modern business and there are companies where these systems are integral to everything (e. g. AI companies). However, in the context of a consulting company they are mainly used to support, supplement, and optimize the

already existing processes. Hence, a model of an IT system would not contribute in a meaningful way to the ontology.

3.4.10 Legal Requirements in the Processes

SCOs are organizations in the social context; German law applies to them, like it applies to every other German organization. It influences their structure and processes. However, discussing the impact of the law onto internal workings of an organizations would go far out of scope of this work. Therefore the ontology omits a detailed description of the legal obligations, but references them abstractly where it is necessary.

For example: Germany law requires every company to pay taxes on their earnings. Depending on the SCO and the way projects are handled, this influences the process that is concerned with taxation. To develop a perfectly correct model, a very detailed discussion of specific processes would be required; this is out of scope. However, interacting with the tax authorities and learning about and filing the correct paper work is an important part of the learning experience for student consultants. It is therefore important for the ontology. To address this fact, but keep the ontology focused, it is condensed into the class *Project Taxation Process* as part of the *Project Process*.

4 Student Consulting Organizations: The Ontology

4.1 Competency Questions

4.1.1 What is the domain that the ontology will cover?

SCOs are student-run consulting firms. In other countries, e.g. in France and Brazil, they are also referred to as *Junior Enterprises* (JE). They do similar work to small consulting organizations, but are staffed – most of the time exclusively – by students. In Germany they are usually a registered association (German: *Verein*) and/or a group associated with a specific university (German: *Hochschulgruppe*). They aim to teach students about consulting as a profession by providing a platform that educates and trains students in the craft and provides them with the organizational means to work on consulting projects.

The domain is a specialization of the a classical consulting firm. It differs especially in terms of professionalization, since companies are focused on profit using education as the means, whereas SCOs focus on the educational aspect and on providing experience, while having profit as secondary goal.

4.1.2 For what we are going to use the ontology?

This ontology is a contribution to the knowledge management of SCOs. It can be used to learn or teach about the domain. It can also be used as a starting point for projects that require a model of the domain.

4.1.3 For what types of questions the information in the ontology should provide answers?

The ontology serves as an abstract description of the SCO domain. It defines all objects and processes that are necessarily and typically present in this type of organization. Therefore it can answer questions like:

- What processes exist and are required in an SCO?
- What roles exist and have to be filled in an SCO?

4.1.4 Who will use and maintain the ontology?

The users of this ontology are the leadership of SCOs in Germany as well as the leadership of the SCO umbrella organizations. The release version coincides with the finalization and grading of this work. If the ontology sees use by the target group, it will be maintained by the author. Access will be publicly provided on a GitHub repository. It is considered a living document, hence not necessarily complete until otherwise stated. Contributions and forks will be possible via the GitHub interface.

4.2 Classes

4.2.1 Agent

Group

Organization

Person

Trainee

Junior Consultant

Consultant

Senior Consultant

4.2.2 Document

4.2.3 Processes

Human Resource Process

Project Process

Support Processes

4.2.4 Projects

4.3 Relations

Verify

(◇ means the relation is implemented in the ontology)

Agent

- All members except trainees and almunus can be corporate officers ◇
- Non-members can't become corporate officers ◇
- Members can play project team roles ◇
- Every agent can play the customer role in a project ◇
- Every member goes through his individual HRP
- An organizational rank has tbd requirements
- Customer, Team, Contract, etc are **part of** a project
- Organizations can only **play** the customer **role** in a project ◇
- Organization can only play external roles ◇

Processes

- All processes have a **next__process** ◇
- **previous__process** should be inferred?!
-

before/after:

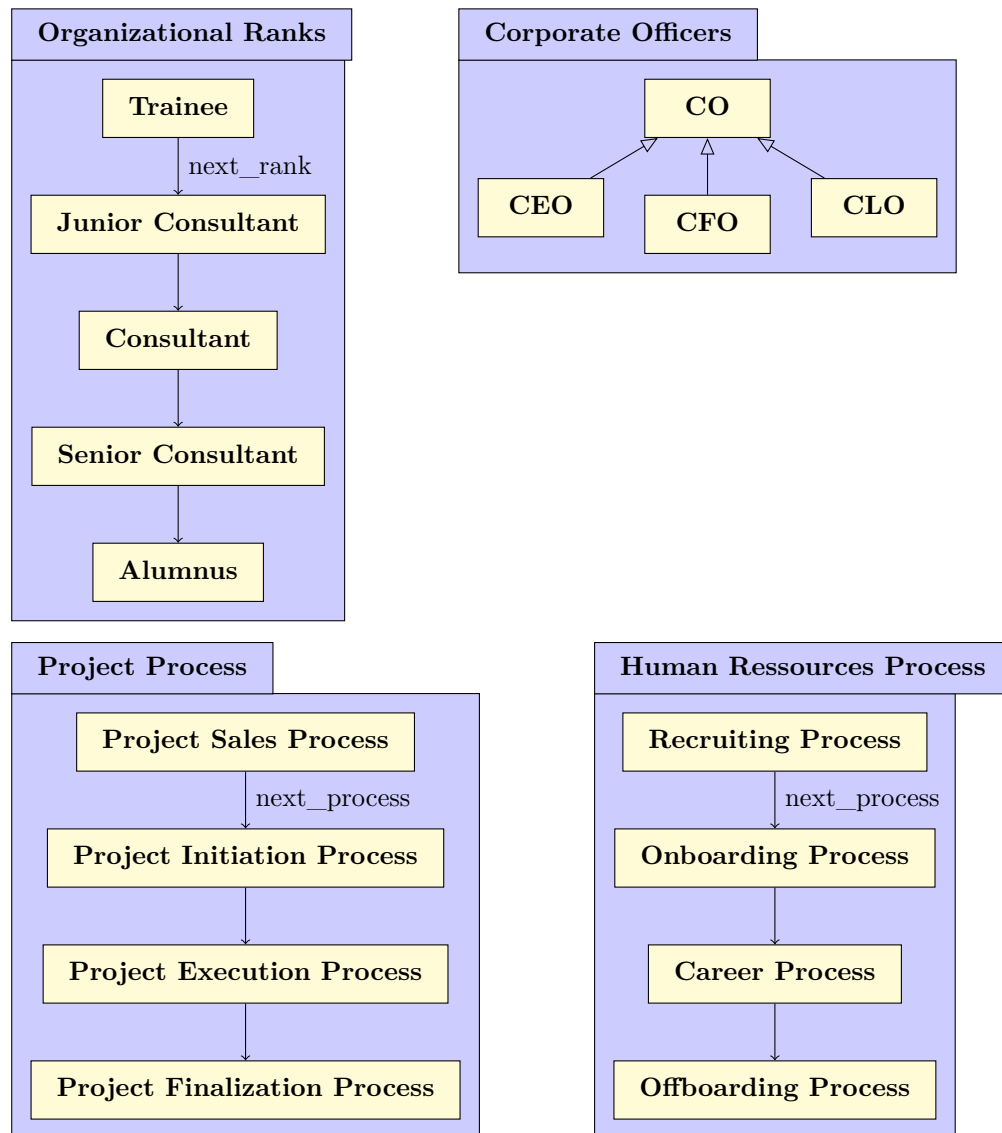
- FIBO: relates to -> precedes/succeeds?
- plays role

5 Result and Conclusion

6 Further Research

Diagrams

Add correct relation



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