Application Form

Innovative Teaching Award 2023[1]

APPLICANT	
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Members of the working group, if applicable[2]:	
PD Dr. Ronald Hochreiter	
Prof. Dr. Axel Polleres	
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Dr. Christian Haas	
GENERAL INFORMATION	
Course level bachelor's	
Course number:	5150 + 5159
Semester:	*every semester* (application submission is for 2022S)
ECTS credits:	4
Course title:	Data Science Lab
Further information on the course:	
(e.g. number of students, prior knowledge of students, position in the curriculum/program)	
30 Students per course, this is the final course of the specialization (SBWL) "Data Science)	

Courses held during the 2022 calendar year (summer semester 2022, winter semester 2022/23) are eligible for the 2023 Innovative Teaching Award. Courses held over two semesters (WS 2021/22–SS 2022) can also be nominated.

[2] Please name all the people involved in the development of the course design. (ATTENTION: only people with teaching activities at WU or the Executive Academy in listed semesters are eligible.) The people named in this field will also receive the award in case of a successful application.

If applicable links to the course's online environment:

https://learn.wu.ac.at/dotlrn/classes/pool/5150.22s/one-community?page_num=0
https://learn.wu.ac.at/dotlrn/classes/pool/5159.22s/one-community?page_num=0

Information on application

Please use the template on the following pages to describe your course. The description should not exceed a maximum of 15 000 characters (including spaces).

In part 1, please insert a short description of your course design (maximum of 180 words). If your course design is selected for the award, the short description as well as the application form will be published on the WU homepage and in the Teaching & Learning Academy.

The detailed description of your course design (part 2) is divided into three parts:

- Section 2a is intended to give the jury an overview of your course.
- In section 2b we would ask you to elaborate on the teaching methods and didactic elements.
- Section 2c is intended to highlight the innovative nature of your course in relation to this year's focus of the award.

The questions mentioned in each section are intended to support you in the description of your course. design.

Please complete the template directly in Microsoft Word and send it as a .doc or .pdf file to lehrenundlernen@wu.ac.at by **February 19, 2023**.

1. SHORT DESCRIPTION OF THE COURSE DESIGN (max. 180 words)

If your course is selected for an award, this text will be published on the WU website along with the submitted application form.

The **Data Science Lab** is the final course of the **SBWL Data Science**, an interdisciplinary specialization **jointly delivered by four WU departments**. It is structured around **group projects** in which students solve a challenging use case provided by a **real-world "customer"** represented by an external industry partner. That design enables students to transfer, synthesize and apply the knowledge acquired in the prior courses in a real-world setting. The industry partners contribute data sets and tools from real-world Data Science problems and students are tasked with managing the project and the customer interactions and developing a solution. In the process, they are supported by an **interdisciplinary team of course instructors** who provide feedback and guidance. Furthermore, groups are paired up with "sparring groups" (another group in the course) to share experiences and exchange ideas and feedback. The course design provides a **unique experiential learning environment** and typically yields front-to-end solutions that provide high business value to industry partners and frequently opens up career opportunities to alumni.

2. DETAILED DESCRIPTION OF THE COURSE DESIGN

2a.) Overview

- What are the learning outcomes to be achieved by the students?
- What are the content elements of the course and how is the course structured?
- What are the elements on which the final grade is based?
- How do you address the focus topic "Innovative Collaborations and Partnerships" in your course?

Key **learning outcomes** of the course are as follows:

- Ability to apply theoretical knowledge obtained in courses 1-3 of the SBWL Data Science in practice
- Working in teams on complex Data Science problems
- Understanding and diving into a concrete problem domain
- Managing and self-learning new tools used in a practical context
- Working out a project plan and conducting a data science project
- Interaction with a "customer" – i.e., the data coach – on a real-world analytics problem
- Applying state-of-the-art Data Science methods from the scientific literature to real-world data problems

Course structure, elements, and grading:

1. **Preference-based group formation:**
   Based on the project descriptions provided by the data coaches in advance, students are invited to submit a list of three preferred projects that they would like to work on. The course instructors use an optimization model to identify an optimal assignment, which usually results in all students being assigned to one of their three preferred projects.

2. **Kickoff workshop** [students, course instructors, data coaches]:
   The kickoff workshop is conducted in three parts:
   (i) Welcome & Organization, including "common pitfalls" and "best practice" talks by the course instructors, (ii) Introduction of the coaches: data coaches briefly present their projects to the students, (iii) "Meet your data coach" sessions where students are encouraged to clarify details about the use case and the available data, ask for additional materials, talk about NDAs (if necessary), arrange a first meeting and agree on first steps.

3. **Project proposal development** [groups]:
   Based on the project descriptions and initial discussions with data coaches, the teams have 10 days to develop a project plan that includes (i) a refined description of the agreed project and its scope, (ii) a time plan with milestones, tasks and deliverables, (iii) a plan how interactions with the data coaches are organized, (iv) definition of roles, and (v) an initial literature list (*10% of final score*)

4. **Intermediate consultations** (mid semester) [group, instructor panel, sparring group]**:**
   Groups present their intermediary results to an interdisciplinary panel of course instructors, who assess the intermediary results and progress (*20% of final score*) and provide feedback and guidance.

5. **Sparring group meetings** [pairs of thematically related groups]**:**
   All groups self-organize at least two meetings with their respective "sparring group" to present their intermediary results and obtain feedback. These meetings are documented in meeting minutes which have to be submitted (*10% of final score*). Each group is also present in the intermediate consultations of their sparring groups.

6. **Final presentation** [all teams, data coaches, instructors]**:**
   The final presentations are delivered in a plenary with all students, course instructors, and data coaches present (the latter at least during the presentations of their groups). Data coaches provide feedback on the results and are invited to watch and comment on the presentations of the other teams as well. The final presentation accounts for 25% of the final score.

7. **Final project report** [groups]:
   The final reports summarize the results of the projects and are also made available to the data coaches. They account for 35% of the final score.

Innovative collaborations and partnerships:

The course addresses the focus topic along two dimensions, i.e., (i) innovative collaborations between teachers of WU and (ii) partnerships between teachers of WU and practitioners.

In terms of **collaboration among WU teachers**, the course has been designed and is delivered in a multi-disciplinary collaboration that spans four Institutes (Data, Process and Knowledge Management; Statistics and Mathematics; Production Management; Corporate Governance) across three WU Departments (Information Systems and Operations; Finance, Accounting and Statistics; Strategy and Innovation). Specifically, the interdisciplinary team is composed of five instructors (4 in each semester) who contribute their diverse backgrounds and perspectives on Data Science to cover and provide guidance on a large variety of topic domains and data analytic needs in the various projects.

With respect to external **industry collaborations** with practitioners, the course is based on real-world Data Science use cases contributed by a diverse set of industry partners (companies, public sector institutions, NPOs/NGOs). Each use case addresses a real business need and provides a real-world setting in which students can apply the Data Science skills they have acquired in the SBWL, conduct their own research, explore creative and innovative solutions, and develop new skills and methods to tackle the real-world challenges posed by their use case.

The course is characterized by intense collaboration and interaction of the student teams with their "data coaches" from the partner side, as well as the academic supervisors (course teachers) during the entire semester. Our experience with the course format shows that students develop great motivation, which we attribute in large part to the practical context and presence of a real "customer". Furthermore, we found that all groups go beyond the methods and tools learned in the SBWL course alone and have acquired new skills and knowledge on tools and state-of the art algorithms within their teams in a **self-learning** fashion: the ability to familiarize yourself with new tools and methods is a base "skill" in a fast moving field like Data Science. We believe that our results show that through the course setup this skill is taught under almost ideal conditions.

The **data coaches** from the industry partner side play a key role and add value to the course by not only bringing in their business problems, but by playing a dual role as ***customers*** as well as ***domain experts***. They cooperate with the teams throughout the semester to prioritize business needs, contribute their domain expertise, provide feedback on intermediary results, and engage in discussions in the final presentations attended by all students, instructors and data coaches from industry. The industry collaborations cover a variety of industrial sectors (in 2022S and W: finance and banking, e-commerce, media, consulting services, public transport, manufacturing, logistics, etc.) and sizes (startups and SMEs, major Austrian public and private sector companies, large multinational enterprises). A total of 13 company partners (BDO, UniCredit Bank Austria, Bank Gutmann, Mimo, Artikuno, APA, Phoron, Dolphin, IBM, ÖBB Rail Cargo, Erste Group, Complexity Science Hub, trustbit.tech) participated in the course in the summer term 2022 and 11 partners (ZAMG, Artikuno, Bank Gutmann, BDO, Jö Bonus Club, Quintik Technologies, UniCredit Bank Austria, ÖBB Rail Cargo, Raiffeisen, IBM and APA) participated in 2022W. We strive for a good mix of long-term partnerships with data coaches that have been participating with new topics over multiple iterations of the course and new partners with innovative ideas and problems.

The wide variety of available topics in the course covers a broad range of industries (see above), business functions (marketing, finance, operations, etc.), strategic levels (from informing strategic business decisions to prototyping models that can be integrated into operations), and methods (data engineering, data management, statistical modeling, exploratory data analysis, machine learning, natural language processing, generative artificial intelligence, etc.). Furthermore, the available topics include projects that tackle current societal problems such as climate change (e.g., ZAMG project on extreme weather events; ÖBB project to improve rail freight transport), improving medical care (e.g., IBM project on prosthesis selection etc.), etc.

By allowing students to submit preferences for projects based on their interests during group formation, we actively incorporate their different backgrounds and experiences in the course. This results in a highly creative atmosphere in which students conduct self-driven research and frequently acquire new skills to achieve excellent results. This is also evidenced by the fact that various company partners have integrated the results into their analytic processes and operations after the course.

2b.) Teaching methods

- Which teaching methods do you use to help your students achieve the intended learning outcomes?
- What is the role of teaching cooperations in the delivery of these methods?
  [note: original question in the form was on international aspects (inconsistent with call and German version) → question translated from German form for consistency]
- Why did you choose this/these particular method(s)? What specific advantages does it/do they offer in your teaching? What do your students learn through the use of this/these method(s)?
- In which way do the students benefit from the teaching methods used in the course?

The course design is structured around a **group project**, which is **complemented by other teaching methods** including short talks by instructors, workshops, presentations and discussions, consultation calls with instructors, intermediate consultations with an instructor panel, sparring group meetings with other groups, etc., in a blended format. Overall, we found project work to be a highly effective core teaching method for this course that can successfully achieve the intended learning outcome, i.e., developing the skills and competences necessary to **successfully carry out real-world Data Science projects in teams**. In particular, we found that the hands-on approach enables students to learn experientially in a real-world setting, fosters intrinsic motivation, self-organization, self-motivated discovery, and creativity.

The **cooperation with external actors** is fundamental to this design, as the industry partner "data coaches" (one or multiple per partner) provide the real-world problem settings for the development of the projects. Furthermore, they provide added value by acting as

(i) **customers**, which allows students to obtain first-hand experience in engaging with customers, managing their expectations and requirements as well as the project scope, communicating their Data Science results in an appropriate manner for their target audience, etc.;

(ii) **experts** that bring in their domain knowledge and contribute stimulating ideas. This allows students to learn to engage with and actively manage the dialogue with domain experts, e.g., to scrutinize data and address quality issues, develop business and data understanding, etc.;

(iii) **evaluators** that provide valuable feedback and help students to reflect on their approach during and at the end of the project. Although the company partners are not directly involved in the grading process, we do solicit their feedback during and after the final presentations.

In our experience, the intensity of these roles of the industry partners varies somewhat across projects and often reflects their role within their own organizations. As a consequence, the nature of the collaborations with industry partners ranges from projects where they take a more pronounced customer role to projects in which students engage in an intense direct collaboration to the point that they become temporary team members.

Irrespective of this and for all topics, we ensure **freedom of creativity** by means of a *standard cooperation agreement* that we formulated in consultation with WU's legal department. This agreement is signed by the industry partners and *limits* the level of detail given in the project descriptions upon which the students choose their project group preferences: rather than being overly specific in describing a particular solution that partners want to be developed, they are advised to provide a case that is mostly restricted to the description of an "interesting" dataset, upon which the students themselves develop and suggest research questions and are free in their choice of methods, which is determined in an iterative fashion together with data coaches and the academic supervisors. Also, the cooperation agreement helps to define mutual expectations.

During ***intermediate consultations with the academic supervisors*** which take place without the industry partners but in front of the **panel of all course teachers**, we ensure that each project group can benefit from the feedback and methodological suggestions of the complementary expertise of all course teachers, not only the specific academic group supervisor. These intermediate consultations are also a place where the students can raise and openly discuss potential issues or challenges in the collaboration with the industry partners, in which case solutions or - if necessary mediation approaches - are jointly developed to ensure learning success (for instance, provision of proxy data for a demonstrator, in case appropriate real data cannot be provided by the company partner or proves insufficient for analysis for some reason).

We ensure students' ***learning from each other*** and from other student groups by so-called "***sparring groups***", that is, each project group is assigned another group as a sparring partner, carefully selected based on the closeness of their topics and/or whether they can be tackled by similar methods and approaches. The

sparring groups are meeting (at least) twice during the semester after the intermediate consultations with the academic supervisors and in preparation of the final presentation to challenge each other and provide mutual feedback, whether the solution approach of the respective other group could be considered in improvements of the own problem setting, or to ensure independent peer-feedback on tackling project challenges.

As instructors, we found that balancing these roles and the expectations of industry partners as well as ensuring a challenging but viable project is an important step that needs to be tackled before the start of the course. Consequently, each industry partner works with an instructor to adequately define an initial project description before the start of the course.

The **interdisciplinary cooperation across WU departments and institutes** is similarly critical to achieving the learning objectives of the course as the external partnerships. The diverse background of the instructors helps to cover the large variety of topics in terms of methodology and domain knowledge. Each team is assigned a primary instructor who acts as a point of contact for both the industry partner and the student team and supports the group with their respective expertise throughout the semester. Beyond that, all groups benefit from the plurality of perspectives of all instructors throughout the course – e.g., through feedback from the instructor panel in the intermediate consultations.

2c.) Innovative character of the course

- Which didactic elements of your course design do you consider particularly innovative with regard to the focus of this year's award "Innovative Cooperations and Partnerships"? *[note: form contained inconsistent question on international aspects → question translated from German application form for consistency]*
- In which ways can your course design be adapted for other courses? Which didactic elements of your course can also be used in other courses?
- Which elements could be improved/reconsidered in a second edition of the course?

The key **innovative didactic element** of the course design is the **real-world project setting** that strongly integrates diverse industry partners throughout the course. Whereas more common didactic elements -- such as case studies or hypothetical projects based on publicly available data -- can also offer some practical perspectives to students, they do not provide a comparable real-world learning environment that fosters experiential learning and interactive, collaborative problem-solving based on direct engagement with industry stakeholders. This experiential learning approach embeds self-directed project work in a highly practical setting, which adds substantial value and in our experience leads to an exceptional level of motivation and dedication among students. This ultimately results in the development of innovative problem-solving capacities, which is also evident in the feedback and high degree of satisfaction of the industry partners, many of which have been impressed by the teams' innovative solutions. This has not only opened up career opportunities for students (to the extent that alumni of the lab have now already returned as data coaches), but also led to recurrent participation and long-term industry partnerships.

Other innovative didactic elements include the use of "sparring groups" where groups with methodologically or thematically related projects are teamed up to present their projects to each other, exchange ideas, and share experiences. This element was not present in the original course design and was added to increase student engagement. We found that students find this format helpful and that groups benefit from the sharing. Furthermore, we found that it allows students to formulate more in-depth questions during the Q&A sessions.

Adaptability
Whereas these partnerships provide substantial benefits for the learning outcomes, developing and managing them requires effort and coordination. In the context of this course, we found that the industry partners have strong incentives for their participation that range from, e.g., getting external "out-of-the-box" perspectives and tapping into innovative problem-solving capacities, staying on top of the state-of-the-art, testing "blue sky visions" in a lab environment, developing risky experimental proof-of-concept ideas outside their daily business setting, or solving specific problems and integrating the results into their business operations. Beyond that, the lab participation is also an attractive opportunity for industry partners to identify and attract talent. We are convinced that similar "lab" course designs can be replicated and adapted for other courses, provided that similar incentives apply.

In terms of **potential further improvements**, we currently consider adding a peer evaluation component as part of the final grade. This could include both a group-internal peer evaluation as a systematic basis to address (very infrequent) cases of uneven workload distribution within the group, as well as external peer evaluation (asking students for the three best final presentations) which would not be used for grading, but could be the basis for a "best presentation award". The latter idea is based on the experience that frequently almost all of the projects and final presentations are excellent and that stimulating friendly competition could make the format even more interesting.

Note: By sending the application form and documents, the applicant confirms that the course design has not received any other awards or grants.

Attachment: Please attach evaluation results, if available.