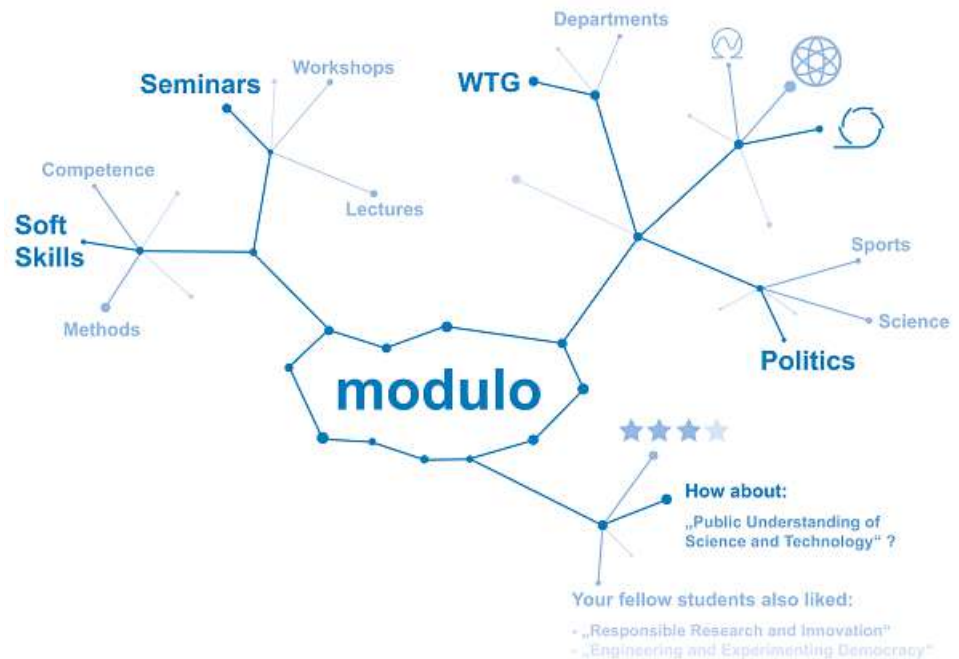




Project Report **modulo**

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How I met your modulo

As I turn my computer on and quickly check my e-mails this morning, I think about the upcoming summer term at the university. "I guess I should finally start looking for some courses..."

After reading yet another "Happy belated new year 2027!" mail from my relatives, I notice a new email popping up in my Inbox. "Ugh, another advertisement mail from my uni ...," I think to myself. But something about it is odd. I'm not even sure why I open it, since the title is not particularly creative. At least the quirky design of the website that it promotes is somehow appealing.

I start skimming the mail, not sure what I am even looking for. "Artificial intelligence, huh?" I think as I am reading some of the usual remarks about the various miracles AI can supposedly perform. "A decent autocorrect would be enough for a start," I mumble.

Talk with me and learn more about your favourite courses! it says on a small chat window popping up.

So now even the fortune-tellers should fear for their jobs? Still, I should actually be looking for new courses, so why not give the website a try?

Welcome. I'm modulX, the new AI course recommender. Who are you?

"Who am I? Why should I tell you my name, let alone 'who I am'?"

I just consider it an act of politeness. Also, how can I help you find a nice course if I don't know you? Maybe you're better off finding a course all by yourself ...

"Hey! No need to be so sassy all of a sudden. I am just concerned with privacy, you know. But well, my name is Student T. (name changed by the editorial staff) and I just started my Master's programme at TUM. So, who are you?"

Privacy? That picture you posted on Facebook last weekend looks like you should be more concerned about that drinking problem of yours.

"What are you talking about? I don't even have a Facebook account."

Oops, wrong Student T. then. Anyway, I'm just messing with you. As I said, my name is modulX and I'm here to help you find interesting courses for you. A little while ago, a group of students developed my predecessor "modulo". It was only a small project, but a lot has happened since then and now here I am, ready to serve.

"I have to say, you almost got me with that remark about Facebook. Wow, I've never heard of that project, but it does sound promising. How do I get some recommendations?"

OK, let's start with your personality: What are your strengths?

"Well, I guess I am more of a creative type. I like communication and working with other people. Besides that, I also enjoy some programming here and there. In the past, I did a few smaller projects including the concept development, implementation and design of web-applications."

I see ... so no strengths, really. You're making this a bit difficult for me. How about this seminar: "Ethics of Advertising - An Introduction to Modern Problems"?

"Oh come on, why are you so rude? Besides, that course sounds pretty dry. Not like something I would find interesting at all."

I'm sorry, I acquire most of my language from social media. Anyway, are you sure about this? What is it about the course that you think could be boring.

"It just sounds like any other 'Philosophy 101' with some literature work and half-baked presentations. I have never been quite into that whole philosophizing."

Alright, I hear your concerns. Still, didn't you say you like communication? What better way of communicating with others than discussing recent topics in a seminar.

"Well, any other seminar would be just as good then ... Besides, what even is 'Advertisement Ethics'? I've never heard of it before."

The course description (found here) says, it discusses the whole communication process between buyer and seller through advertising. As you are involved with creating web-applications, you will surely have to deal with promoting your products at some point.

"Hmm, give me a second to read the description..." I write, and then follow the link to the course webpage. To my surprise, the chatbot was right: although I don't know all of the terminology in the description, I recognize some topics I really enjoyed during my lectures. The seminar could indeed be helpful for future projects. A slight feeling of unease makes me hesitate to return to the chat window. Was this just a lucky strike? Surely, a piece of software could not predict my interests that well... or can it?

"Actually, you might be right. I will at least give this seminar a try. How come you were so sure about this course?"

I'm glad you think so! I guess it comes from years of experience and learning from mistakes. Some say that I can look at a portrait of somebody and tell what they are interested in, but I'm not one to brag. Actually, I prefer an open conversation to find out how I can assist you best.

"Either way, I'm really impressed. Thanks, modulX! :)"

Don't mention it. Please let me know how the course went afterwards. I'm always happy to learn a new thing or two. And go tell your friends about me ;)

"Sure, will do."

With a strange, yet happy feeling, I close my browser and gaze at my desktop for a few moments. Eventually, the growling of my stomach makes me get up to fetch some muesli from the kitchen.

"I have to check out this whole A.I. project." I am thinking aloud as I return with my bowl of customized cereals and start doing some research on the student group who developed modulo.

"TUM: Junge Akademie – Project Report 2016/17"? That sounds interesting ...

Abstract

In our project, we developed a course recommender system for TUM students, based on artificial intelligence. The goal was to see whether artificial intelligence might help students in their decision on which course to take. On a long-term perspective, such a course recommendation system based on interests would be advantageous for lecturers and the quality of university education as a whole by effectively increasing the ratio of students participating in a lecture who are actually interested in the respective topic.

1. Background

So-called “Artificial Intelligence” (AI) is frequently discussed in science as well as in the media. There is a wide variety of situations where we are already using AI in daily life – with or without us being conscious of it. The fact that this topic is new, together with its capability to revolutionize our society on a large and small scale, led us to the decision to investigate educational decision-making processes in an AI context.

Since “Artificial Intelligence” is a very broad concept, it became clear very soon that, as a team, we had to focus on a narrower sub-area of the topic. Since the TUM: Junge Akademie is a student program, we wanted to analyze something related to our university, where all resources are relatively near and reachable after all.

Artificial Intelligence has to this day not been included in any way within the educational system. Thus, we first considered whether it would be possible to introduce it into our educational system, and if so, how? In a straightforward way, we looked into applications of AI related to our personal experiences as students. One way to use AI would be to generate recommendations for interdisciplinary courses for students based on their interests. In contrast to already available module lists, the recommendations are not selected via an “old-school” keyword search, but via an intelligent algorithm. By focusing on interdisciplinary modules that every TUM student can select for his/her curriculum, we also reach a broad audience and can evaluate the benefit of such a recommender system in general.

The rationale behind this area of interest was that it is advantageous for the quality of a lecture if the students attending it are genuinely interested in the specific topic. Interested students learn

faster without having to be pushed, they participate more and there is less need for continual repetition until everyone has understood the taught concepts. Of course, this is a vision that will not be implemented in the near future, since such a big project needs tests and audits, and the interests of many stakeholders have to be taken into consideration. But our project tries to lay a sound foundation for further activities in the field of Artificial Intelligence within the educational system.

2. Goals and Methods

To research the general need for such a service, we set ourselves the following hypothesis: an AI-based recommender system that delivers suggestions for interdisciplinary modules is helpful for the decision-making process of students selecting such modules.

In order to test this hypothesis, we started by conducting several qualitative interviews with members of our target group, TUM students. In these interviews, the students expressed what we already anticipated from our own experience: an overall wish or hope that such a system would help them in the future, since there is no sort of overview and there are too many unsorted choices in the current system of course selection. To get a better impression of what kind of features such a recommender system should have, we also asked about features they would like the system to display.

To further narrow down both the necessary and feasible features for an AI recommender system, we conducted a literature review about Artificial Intelligence and talked to the departments in charge of the current course selection system at TUM. Based on this analysis and the interviews, we then implemented a prototype of an intelligent course recommender system. A schematic flowchart of the prototype is given in Figure 1.

By setting up this prototype, we wanted to test two aspects: First, whether such a system was realizable at all, and secondly, if so, whether it would be of use to students. Concerning the first aspect, we got an affirmative answer. We successfully implemented a working prototype that is online and can be used. This prototype is a proof-of-concept, since it does not include all modules, but only the interdisciplinary ones held at WTG@MCTS (former Carl-von-

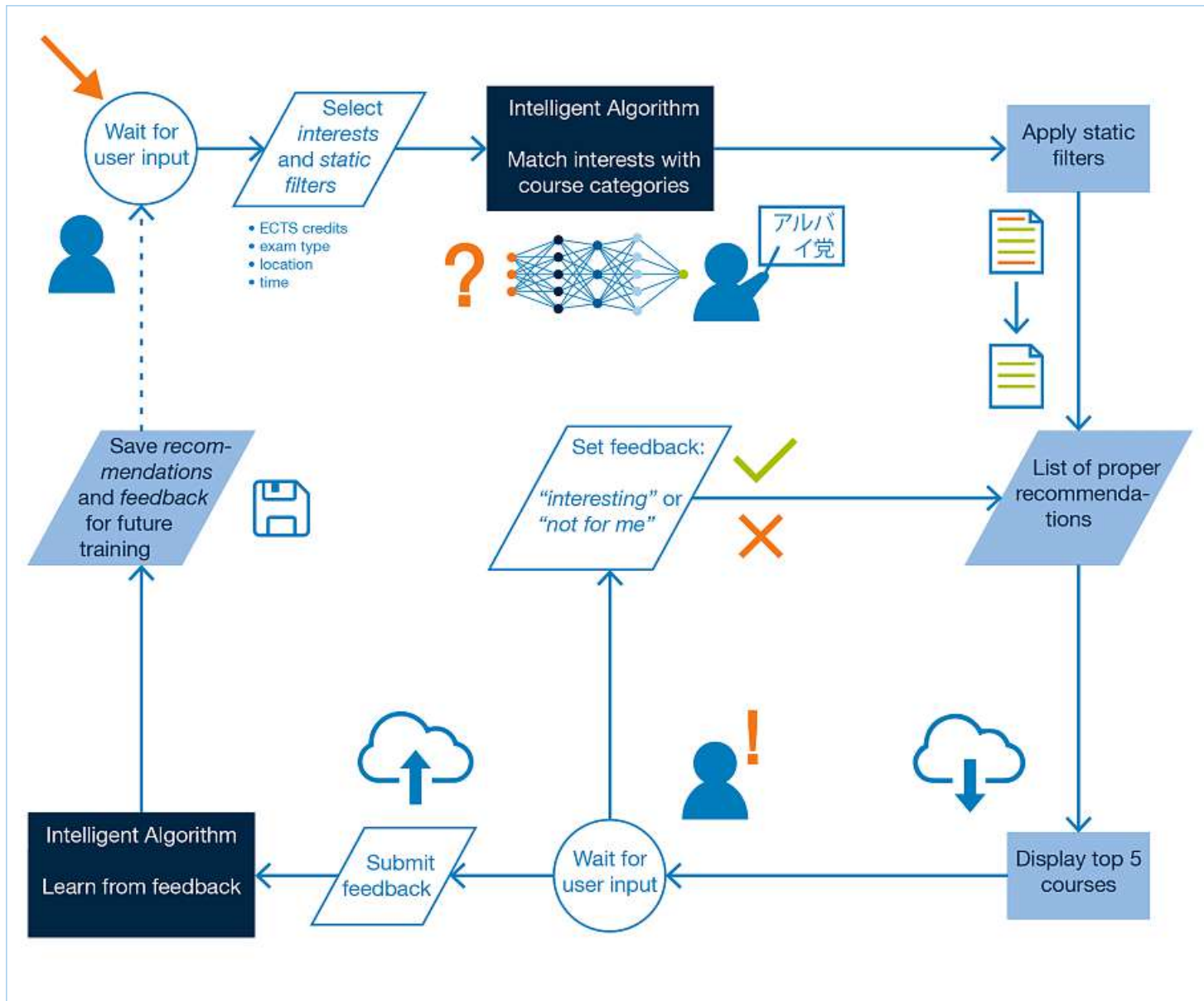


Figure 1: Flowchart of our prototype *modulo*.

Linde Academy). Although this set is of course only a fraction of all modules of TUM, it already covers a broad range of disciplines and is therefore suitable for testing the recommendations. Furthermore, we focused on one criterion for the decision: personal interest of users. Other criteria could, for example, be the type of assessment involved, the expected workload, the time at which the lecture is held, etc. Most of these have only played a minor role in the current prototype, as they are usually implemented as mere filters. A second point worth mentioning is that the system working on a small scale for a well-defined subset of modules is not easily scalable to cover the whole variety of courses. There are several technical hurdles and administrative barriers preventing a simple transfer of a working system from a small to a larger scale. Depending on the information processed and displayed by the program, one of those hurdles is data security, because it is prohibited by German law to make all the available information public for students who are not allowed to take a certain module. Since every student is able to choose from the WTG@MCTS modules, this aspect did not play a big role in our prototype. Still, it illustrates how quickly an algorithm concerning sensitive data could overstep a legal “line”.

In order to examine the second part of the question, i.e. the usefulness of the system for students, we conducted a second, quantitative survey with TUM students who tested our prototype hosted on a web server, and who were then asked about their user experience in a subsequent questionnaire.

3. Outcome and Discussion

159 students participated both in the test of our recommender system, *modulo*, and in the survey. Around 30% of the participants consider the prototype version of *modulo* to be helpful for finding suitable modules. Besides, it should be stressed, that 87% of the participants believe, that a future version of *modulo* is able to support their decision making (See Figure 2a). In the future, the current recommender system should be improved by providing an even larger amount of suitable training data (thus yielding a better match of interests and suggestions). Furthermore, additional features (e.g., free text input for interests instead of pre-defined keywords) and a greater selection of modules (not only interdisciplinary ones) were mentioned by many users. This clearly shows that there exists a great interest in having an easy-to-use system that supports students in finding suitable modules.

Another pair of answers strengthening this assumption is to what extent the participants would trust a course recommender system like *modulo* to decide which modules to take. While 28% would accept the suggestion for the current system (options 1 to 3 on a 6-item scale), 74% would only provisionally accept them for a future system with the above-mentioned improvements. (See Figure 2b)

Except for the advantages concerning clarity, i.e. there are fewer modules to scan through, and time (stated by 70% and 74% of participants, respectively), a huge majority of 91% of the participants expressed curiosity regarding the suggestions of a further AI-based course recommender system. (See Figure 2c) From this answer, it can be seen that many students think that an improved recommender system would make university life easier for them, at least in relation to this specific aspect of course selection.

There was also a free text answer field for suggestions and feedback, where many users expressed ideas for improving the user experience or front-end, and where they suggested additional features. Two main challenges of the current prototype were commented on by most of the users: the current GUI and the success rate of the suggestions. The idea itself as well as the impact of a future version of *modulo* is considered as great and exciting. This correlates well with the curiosity question mentioned above.

But, of course, it is not entirely as simple as that. We realized as we were working on the prototype that a lot of obstacles remain in the way of such a system. A major aspect to consider are the strict laws concerning data security and protecting personal data. Therefore, not all functions that might be desirable could be implemented in such a recommender system. Here, close cooperation with the responsible contact points within the university's organization is of utmost importance. This is already difficult for lectures coming from only one department, but it gets more complicated if a future system were to encompass all modules available at TUM.

4. Summary and Future Goals

The goal of our project was to analyze whether a course recommender system based on Artificial Intelligence would help students in taking a decision on which courses to take. This question can be answered affirmatively for a future, even more sophisticated version of the prototype we developed. But of course, such a system

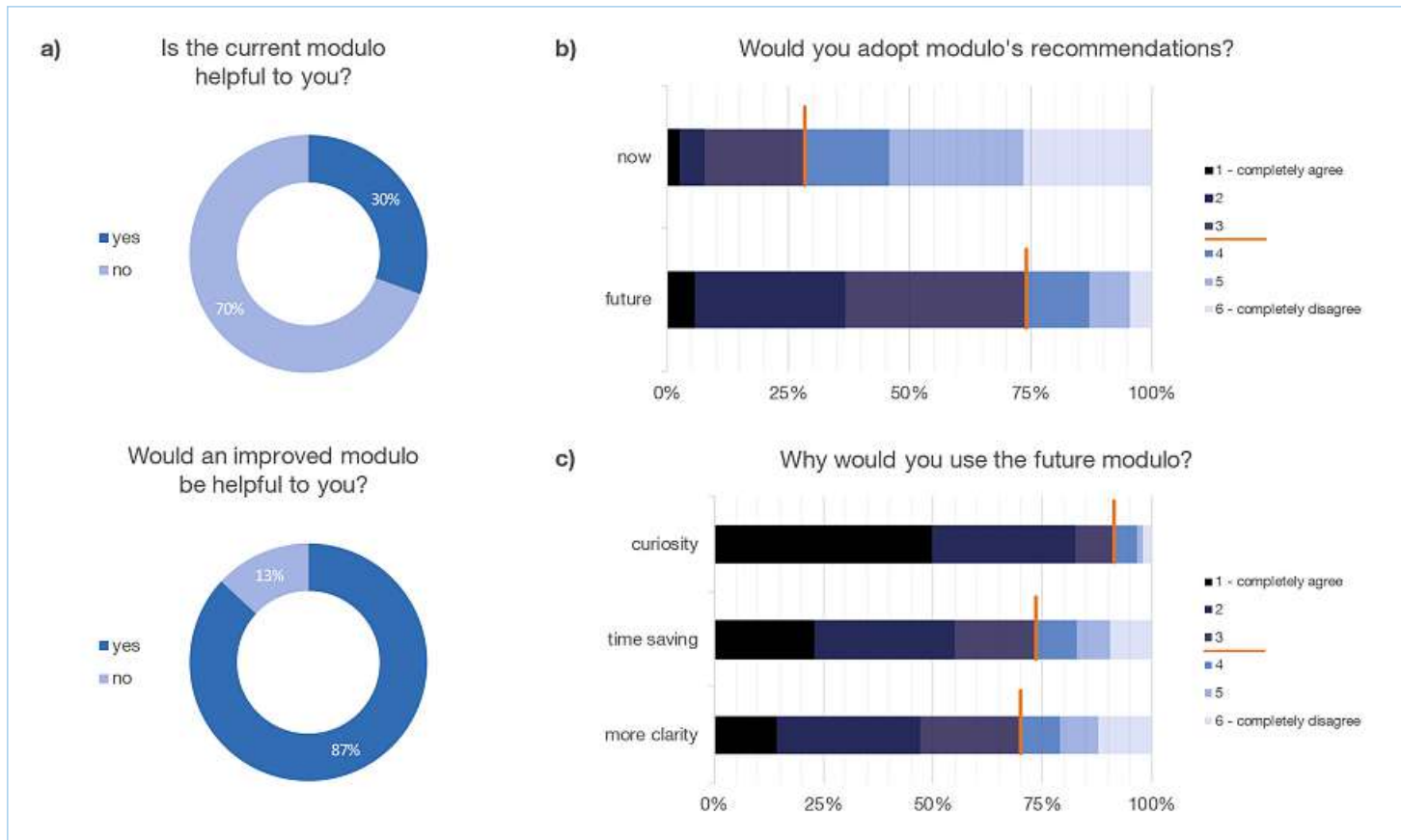


Figure 2: Selected questions from the survey.

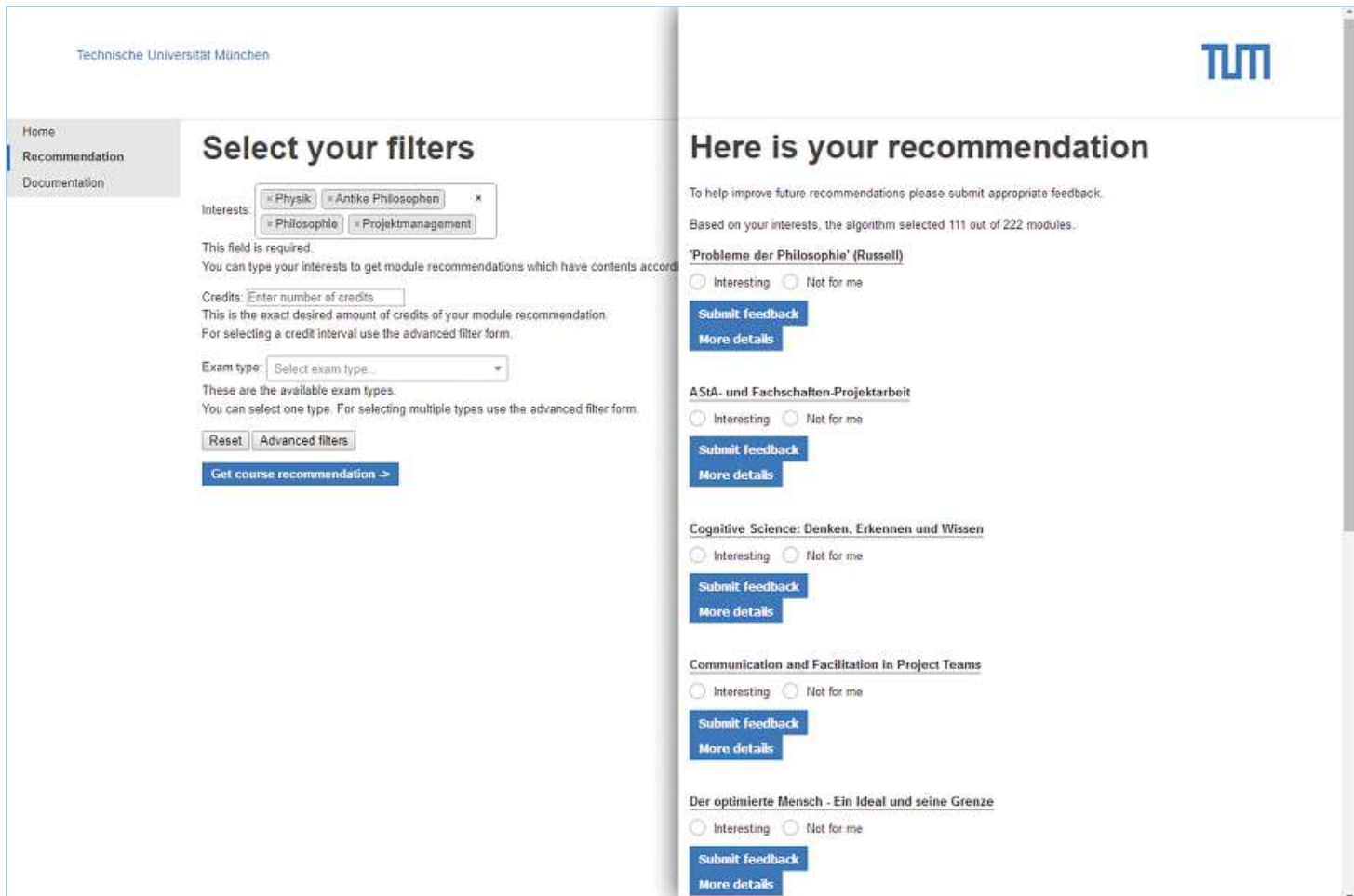


Figure 3: Screenshot of the Prototype

is only valuable if it is maintained and updated. Therefore, we are at the moment checking whether a smooth handover of the system as a whole to a department of TUM might be possible – consensual interest exists and has been expressed for such a long-term solution, so we are confident that our findings will be of use for future projects.

In order to enable the system to be useful in the future, the improvements mentioned above have to be implemented first. Another survey would then have to show whether the new system is good enough to fulfill the needs of students and lecturers, while respecting the legal and administrative framework in which it has to function. Besides, the positive effects for lecturers and for the quality of lectures have to be proven as well, since they have not been analyzed in this project yet. This could be done by means of interviews about the improved recommender system, but might on the other hand be hard to quantify since in general it will be difficult to separate the effect of an AI-based “*modulo 2.0*” from other influencing factors.

Our project has shown that an intelligent recommender system for course modules would be accepted and welcomed by most of the students for its advantages in relation to time, effort and clarity, but also out of curiosity. But this will only be a success if the program is maintained well and the courses are kept up-to-date. This could and should be the focus of further research upon the topic. If there was a working system helping students in the future, the implications for lecturers should be analyzed as well. Since, to our knowledge, there is no similar project in other universities up to now, this case would have a lighthouse character for future developments in this direction.

Despite modulo still being in a prototype phase, there are three central findings of our project:

1. Even rather simple projects in a specific sub-area of the university become complicated as soon as user data has to be processed. This is a good mechanism for protecting personal data, but it takes up a large amount of time and effort that has to be considered in project planning.
2. Such a project can only be successful if every stakeholder is involved from the beginning. If the stakeholders are people with busy schedules, this might significantly delay project progress, but their participation and support is essential, even more so if the project is trying to implement something new und unprecedented.
3. From an implementation side, Artificial Intelligence might be more complex than “standard software” since the way solutions are found is not explicitly programmed as a “hard-coded” algorithm, but, rather, the “intelligent” part takes on the search for a solution. This is the core of Artificial Intelligence, but it also makes it harder to evaluate the found solutions and to debug the system if the output does not meet the desired criteria.

Acknowledgement

First and foremost, we want to thank our two mentors Prof. Dr. Sabine Maasen and Dr. Florian Röhrbein for all the insightful discussions and ideas as well as Dr. Jan-Hendrik Passoth for his helpful contributions regarding the realization of our idea. Furthermore, we want to express our gratitude to Prof. Dr. Gerhard Müller as well as M.A. Simone Gruber for their TUM-specific advices concerning possible chances and risks of the project. A final big thank you goes to Dr. Alfred Slanitz and Andrea Bergler from WTG@MCTS for their valuable input, both in the form of course data and ideas about further improving our prototype.

modulo
TUM

The AI course recommender system and a manual on how to implement similar projects in the future.

Did you ever get lost while searching for interesting courses?
Did you ever hear of a TUM course named "Acting without knowing"?

That's where our solution 'modulo' aims to help.

Nowadays, almost every curriculum at TUM contains credit points that have to be obtained in interdisciplinary courses. This is an advantage, but because of the vast range of courses the choice is also very perturbing for students. Therefore, we aim to build a tool that – based on user preferences – recommends interesting options to them.

During this project, we also want to document our findings on which decision processes are important for such a project. Based on this, we will create a "how-to" for the development of future AI-based recommender systems.

We will reach our goal by conducting (qualitative) interviews revealing the students' concrete demands. Then, we have to obtain, check, and process the data we need to implement our system. Finally, we want to thoroughly evaluate the benefits of the finished product.

By that, we want to accomplish several goals:

- students will find interesting courses they otherwise would have missed
- lecturers will speak to a more interested audience, since more students will choose topics based on their interests
- other institutions (of TUM) implementing their own recommender systems for similar problems will profit from the documentation

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TUTORS Benedikt Bick, Michael Ciomaman

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Poster 1: Annual Conference 2016

modulo
TUM

The AI course recommender system.

Did you ever get lost while searching for interesting courses?
Did you ever hear of a TUM course named "Acting without knowing"?

That's where our solution 'modulo' aims to help.

The modulo app

BACKGROUND
Nowadays, almost every curriculum at TUM contains credit points that have to be obtained in interdisciplinary courses. This is an advantage, but because of the vast range of courses the choice is also very perturbing for students. Therefore, we aim to build a tool that – based on user preferences – recommends the most fitting options to them. This tool should facilitate the choice of the students by utilising Artificial Intelligence (AI). In principle, an algorithm matches some user input, e.g. the student's interests, with the course database. Actual intelligence is coming in when the user is giving feedback on the recommendations and the system thereby 'learns' which topics, and thus courses, are more related than others and more likely to be suitable suggestions. The more the system is used, the better the recommendations will get.

GOALS AND METHODS
The primary goal of our project is to analyse the decision-making processes of students at TUM and map them onto a smart recommender system, eventually trying to assist students in these processes. We narrowed our field of interest to a single TUM Department (Electrical and Computer Engineering) in order to reduce the time and effort for both programming the system and getting an overview over the students' decision-making when choosing interdisciplinary courses.

To get a qualitative overview, we are interviewing students with regard to their experiences with said decisions and the criteria they establish. We simultaneously start to gather data from the university and learn more about the basic functionality of AI systems and which specific features we can use from existing algorithms. Lastly, the progress in our project is documented to learn more about the decision-making processes the developers – so we ourselves – are undergoing during their work.

OUTCOME AND DISCUSSIONS
For the interviews themselves we used a qualitative approach in order to understand a student's process when deciding which interdisciplinary course he or she would attend. We focussed on two main aspects when conducting the interviews. Firstly we were interested in how the students had chosen their interdisciplinary courses and their thoughts regarding their decision process. Secondly, we asked the students whether and how they would use our recommender system as well as what they wanted our recommender system to be like, i.e. what input should be possible and how they would prioritize these criteria.

The first step towards the AI recommender system itself is a detailed plan of the program and its structure. Therefore, we worked out class diagrams and made considerations about the content testing. Also most of the required data has been acquired from the Carl von Linde-Akademie, which offers a broad variety of interdisciplinary courses. Additional data will probably be obtained directly via TUMonline. For testing purposes, we can also generate 'synthetic' course data to test the recommending abilities of the algorithm.

SUMMARY AND FUTURE GOALS
The algorithm we want to implement is taking shape, step by step. We will try to adapt it to our findings from the interviews as accurately as possible. Nonetheless, there will be discrepancies between the technical possibilities and the demands we try to meet. Compromises, e.g. regarding the range of functionality, are inevitable.

A first 'proof of concept' prototype of the recommender system, which we want to use to examine the general feasibility of our idea, should be running by April 2017. From there on, we can test the reception by the students and further investigate more aspects of their decision-making with specific questions at hand.

JANUARY 2017

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Poster 2: Evaluation Day I

modulo

The AI course recommender system.

ABSTRACT We aim to tackle a problem many students at TUM have faced: choosing an interdisciplinary course within the vast variety of different topics. By implementing the prototype 'modulo', we want to test our hypothesis:

HYPOTHESIS An AI-based recommender system can assist students with their choice of interdisciplinary courses at TUM.

To maximize our productivity, we split the workload in three parts. This diagram highlights the key milestones within the different areas over the course of our project.

Implementation:
Goal: set up a first full-concept prototype of a basic recommender system.

Conceptual design:
Design the architecture on paper - component diagrams and use cases.

Coding:
Python code in Django web framework. Intelligent learning with Tensorflow and a linear classifier.

GUI:
Design an HTML and CSS interface for the testing phase.

Future developments:
User-friendly rework of the frontend. Final prototype with dataset from the testing phase.

Decision-making processes:
Understand how a user might select courses. Relevant facts and criteria.

Interests / Categories:
Predefine possible user interests. Match each course with suitable categories.

Usability study:
Test the prototype with random users to improve frontend design.

Final study:
Conduct a study to validate the overall usefulness of the prototype for choosing courses (test of our hypothesis).

Data acquisition:
Goal: gather information about user opinions as well as the data for the database.

Qualitative interviews:
Conduct interviews with open questions to identify a user's decision-making process.

Usability study:
Test the prototype with random users to improve frontend design.

Final study:
Conduct a study to validate the overall usefulness of the prototype for choosing courses (test of our hypothesis).

Documentation:
Goal: write a documentation about the progress and decision-making processes within our project.

Format:
One chapter for each stage of the process. Make it easy for each target group to find and read relevant content.

Draft:
Draft chapters about every process stage is written by one person. Obtain opinions of all group members.

Revision:
Assemble individual chapters in reasonable order. Find a consistent writing style.

Finalization:
Identify relevant content and develop a guide about which chapters to read for each target group. Release the documentation in printed and digital form.

JUNE 2017

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inspired by TUM Junge Akademie

Poster 3: Evaluation Day II

modulo

The AI course recommender system.

During the last year, we implemented an AI-based recommender system for interdisciplinary courses at TUM with the help of WTG@MCTS. We evaluated our prototype "modulo" by conducting a survey with 159 students from different departments to test our hypothesis:

Is modulo helpful to you?

An AI-based recommender system can assist students with their choice of interdisciplinary courses at TUM.

The main question we answered, is whether or not there is a demand for a system like modulo among the students. More than 87% of the students think that a finished version of the prototype with more features and a polished GUI would indeed help them with finding courses.

Prime reasons for using modulo now and in the future are improved clarity and time saving compared to manually scanning the course catalogue as well as just general curiosity about its recommendations.

Follow the QR-code and test modulo yourself!

To give an impression of the students' feedback so far, we listed some of their free-text comments from the survey below.

More transparency in obtaining the recommendations.
The idea is great — but it's still a long way to go.
Group interests in thematic clusters.
Good luck! Nice work!
Needs quicker response and a better GUI.
The list of interests is too long and difficult to handle.
Add German translation.
Give more info on the courses.
It was a bit complicated to use at first, but the concept is brilliant!

OCTOBER 2017

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Poster 4: Annual Conference 2017