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Potential of AI-supported recognition tools for higher mobility and more permeability in the higher education system

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Abstract

Three application scenarios for AI-based tools are being analyzed to support the recognition process for university and program changes. These are 1. AI-supported structuring as an AI Module Analyzer, 2. AI-based support for the academic sector in assessing criteria for recognition as an AI Module Matcher and 3. an AI Chatbot to support students in consulting and processing of the application. Practical tests with generative AI and a combination of generative and semantic AI were conducted in several variants, which show as a proof of concept that despite all the difficulties that still exist, there is great potential for AI-based tools to make a decisive contribution to transparent and efficient recognition processes in the near future and thus to increasing permeability and mobility in the European higher education system.

1 Introduction

Physical as well as virtual student mobility at national and international level is increasingly being supported and propagated and, in addition to the classic move to another university or temporary mobility abroad, more and more diversified forms of mobility such as Microcredentials and European Universities are becoming established at universities: However, despite great efforts, the digitized administration of mobility, for example with Erasmus without Papers, the administration of mobility is

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still largely in its digital early stages (Gilch et.al. 2023). This applies not only to Germany, but also to other European countries, even though digital exchange formats such as EMREX have been successfully realized. The reason for this could be that the variety of achievements to be recognized at the level below full degrees is not defined by comparable attributes and the lack of semantic similarity leads to many variations in the formulations. Mostly, when moving between universities, for example after a stay abroad, modules are fully or only partially recognized. Often, however, it is only partial modules, individual courses, module clusters, Microcredentials or other achievements and certificates that do not come from a very similar degree programme, but from almost any degree programme or course, but which convey skills and learning content that are similar to the modules and achievements to be recognized.

Various efforts are now being made to schematize the diversity and variations in the description of competences and learning content and to develop corresponding standards to map them. In the European context, these certainly include the Europass initiative and the European Digital Credentials for learning, which include diplomas, transcripts of records and a wide variety of other types of certificates of learning achievement. Standards such as the European Learning Model (ELM), which is based on the European Qualifications Framework (EQF), and ESCO (European Skills, Competences, Qualifications and Occupations) or ELMO are intended to help create a Europe-wide classification of skills, competences, qualifications and occupations, with which the qualifications acquired are stored digitally (Gottlieb & Bacharach 2023). Exchange formats such as Erasmus without Paper (EWP) can then use these standards to digitally exchange the data that can be encoded in them between institutions. However, only a semantic check carried out by a human being allows an assessment to be made as to whether a competence acquired at a host university abroad does not differ significantly from the competences to be acquired at the home university and must therefore be recognized as equivalent.

Such international exchange formats and other national initiatives such as the Single Digital Gateway (SDG) at European level or XHochschule (XHEIE) in Germany are currently being driven forward with great vigor. At German universities, however, very little of this seems to have been implemented in degree programmes and by those responsible for degree programmes and modules (Gilch et. al. 2022). Examination regulations, module handbooks and module descriptions are already being created in many cases with the support of the corresponding Student Information Systems (SIS). However, this is mainly used to record formalities such as numbers or names, e.g. semester numbers, ECTS, workload and examination forms in a standardized way. In order to record the teaching content and competences to be taught, the systems generally use free text fields in which the module coordinators can enter free text passages, which are then used unchanged as part of the module description and output on websites or in PDFs, for example. The use of free text fields means that neither the standardization of data fields nor a common understanding of the information they contain in the sense of a semantic description is used. If universities then use different SIS or Mobility Management Systems (MMS) and teachers at other universities dispense with SIS support altogether and instead base module descriptions on Excel lists and create texts in Word and PDF formats, then the diversity of the various documents, structuring and semantic interpretation can become almost arbitrary, so that enormous efforts are required to translate this different information back into exchangeable and comparable digital formats.

The study, which the HIS Institute for Higher Education Development (HIS-HE) conducted in close cooperation with the Lübeck University of Applied Sciences (TH Lübeck) and SemaLogic in autumn 2023 in Germany for the HRK project MODUS (https://www.hrk-modus.de/), addresses this problem. MODUS aims to further improve recognition and credit transfer practices at universities in order to achieve greater transparency and flexibility in recognition and to enable mobility and permeability. Its fourth future workshop on the potential of using artificial intelligence in recognition and credit transfer processes aims to contribute to the strategic implementation of AI-supported systems in university administration by identifying and discussing application scenarios for AI in recognition and credit transfer processes and analyzing their added value and feasibility. Specifically, three use cases in the

recognition workflow were defined, which should be analyzed within a study regarding their potential for the use of AI tools:

- AI Module Analyzer: structuring and reflecting on module descriptions in terms of stringency, completeness and competence orientation with the help of AI-based tools.
- AI Module Matcher: Support for the academic sector using AI-based tools to check content criteria as a means of matching achievements and performance requirements for the recognition of student achievements.
- AI Chatbot: Chatbots to support students in the provision of information and administrative processing by the university as part of recognition and credit transfer procedures.

For this analysis, HIS-HE interviewed 14 experts in Germany who are involved in AI at universities, as well as 17 current projects from the federal-state initiative to promote artificial intelligence in higher education. The central part, however, were empirical practical tests in which the potential that can be realized for these three scenarios on the basis of the generative AI tool ChatGPT was analyzed (in this study, ChatGPT+ 4.0 was used in the version prior to 13 February 2024). The proof-of-concepts achieved in the prototype laboratory can now serve as a basis for developing real applications that can then be used to test the practical suitability of these AI applications in university operations on a broad scale. A general and comparative analysis of different AI technologies or the development of specific AI applications was not part of the study.

2 AI tools, project analyses and expert interviews

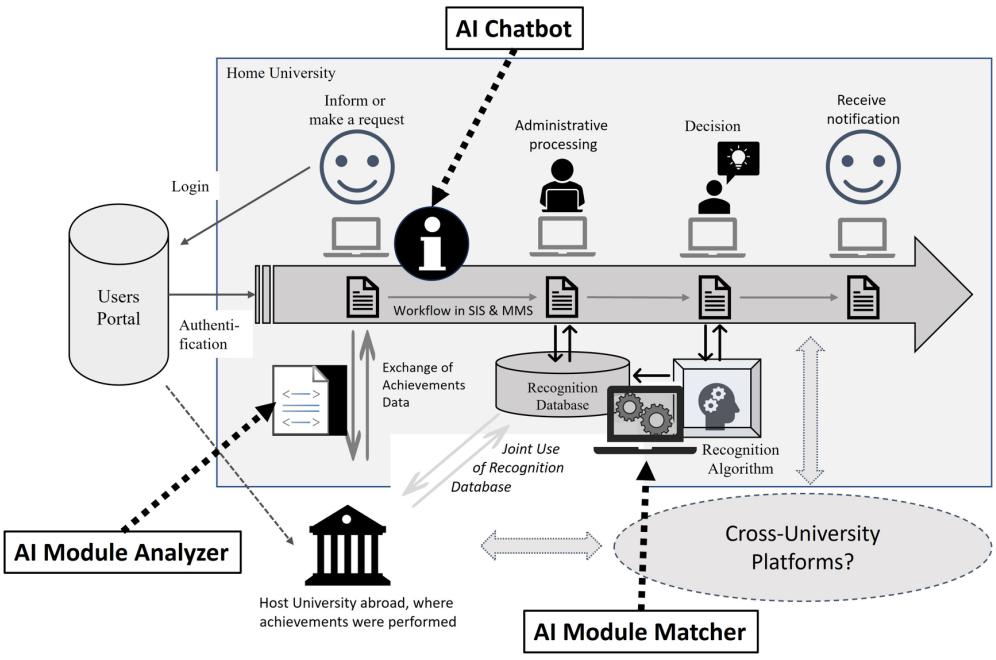

Figure 1: Digital recognition workflow with the three AI tools analyzed (modified from Gilch et. al. 2023).

As the basic digital workflow of recognition processes is already described (Gilch et. al. 2022, 2023), it should now be analyzed how these workflows can be supported by AI tools. The HRK Future Workshop has defined the three application scenarios AI Module Analyzer, AI Module Matcher and AI Chatbot, which can be integrated into the digital recognition workflow as shown in Figure 1:

- The AI Module Analyzer can be used to analyze and prepare in a structured way information about learning achievements, teaching content imparted, and skills acquired, which is usually available in more or less structured module descriptions in the form of data or also as running text. This can be available either before or after the data transfer between the participating universities in a form that makes it easier for the actors involved or subsequent technological processing steps to generate or make a decision on possible recognition. The AI Module Analyzer should be able to process a wide range of module descriptions according to standardized formats and taxonomies and, for example, also translate module descriptions. In principle, it would then also be possible to use the AI Module Analyzer as an AI Module Designer if it is used during the creation of module descriptions to structure the textual descriptions of learning content and competences freely entered into a module management system by the module coordinators during input, to assign them to semantically suitable reference models and thus also to verify them.
- The AI Module Matcher supports the actual decision-making process regarding recognition by comparing the information on course content and acquired competences listed in the module descriptions of the host university with the modules applied for recognition at the home university and identifying formally and semantically motivated similarities and (significant) differences. The AI Module Matcher should be able to draw on pre-structured and verified module information, implement clearly definable rules and also, for example, use recognition databases in which recognition decisions that have already been made are stored. As a result, the AI Module Matcher could generate decision proposals that are then validated and, if necessary, confirmed by the decision-makers at the university.
- The AI Chatbot enables students, as future applicants, to communicate with the recognition system in their own free language. Students can find out which modules at other universities (e.g. international partner universities) are particularly well suited to their individual study programme and how likely it is that modules from other universities will be recognized later. The AI Chatbot also provides advice on the application process - both for the actual recognition and in advance, for example when applying for Learning Agreements. Ultimately, the AI Chatbot could be integrated into a general AI-based chatbot for student counselling, as is already being prepared or developed at many universities.

The current review of research and development projects in the German higher education landscape reveals a primary focus on the development of AI-based chatbots for student counselling, with the majority of projects relying on symbolic AI technologies and generative AI only being considered so far. The study results are largely based on the objectives pursued by the projects, with few reports on current progress or necessary adjustments. Future considerations aim to improve the usability and flexibility of chatbots through the use of generative AI, including public tools such as ChatGPT or custom-developed systems, to enable more in-depth counselling. A specific project at TU Berlin (USOS 2024) plans to integrate personal data into digital advice, humanizing communication through generative AI and translating it into formal database queries. The implementation of such systems requires strict attention to data protection and strategies to avoid erroneous generative results, with the challenge compounded by the lack of suitable training data for generative AI.

In interviews with experts from universities who work with AI and some of whom are also active in AI research, it was found that there is no substantial personal experience with AI-based administrative applications, apart from the personal use of publicly available tools such as ChatGPT. Their experience

is mostly focused on expert systems, which are considered to have development potential, while opinions on generative AI vary between euphoria about the possibilities and skepticism about validity and data protection. AI Chatbots are seen as the most promising application, particularly in student counselling, where they offer the opportunity to provide more comprehensive digital counselling services by drawing on generative AI. The experts see less potential in the use of AI Module Analyzers, although support as an AI Module Designer for the creation of study programme and module documentation is considered useful. The experts take a critical view of the use of generative AI in recognition decisions due to the requirements for transparency and legal certainty, although such tools could support the preparation of decisions. Blanket contractually agreed recognition within European University Networks is seen as a more effective solution for optimizing recognition processes.

3 Empirical practical tests

As a central element of the study (Gilch et al. (2024), empirical practical tests were conducted to investigate the extent to which generative AI can already be used today as a stand-alone solution or integrated into a fixed application and additionally combined with symbolic AI in order to realize the three application scenarios. The procedure and results of the three test models will be demonstrated and described using the AI Module Matcher, as only this has been tested in all three models to date. A total of around 10 module handbooks, module descriptions and training regulations from various degree programmes, universities and professions were analyzed. In order to ensure the comparability of the three test models, the same modules from identical universities were tested in all models.

In test model 1 (see Figure 2, on top), HIS-HE used ChatGPT+ 4.0 directly as the AI Module Matcher via the website provided by OpenAI. The individual process steps are as follows:

- The question is first formulated as a prompt that is as precise as possible. The necessary data corpus (module descriptions) is made available to ChatGPT+ 4.0 either directly as a link to the websites of the universities or as an uploaded pdf file.
- In the second step, the prompt is optimized, and the chat is fine-tuned.
- In the dialogue between the user and ChatGPT, an attempt is made in loops based on natural language to achieve acceptable results in relation to the problem.
- If errors and hallucinations permanently impair the validity of the results, the prompt used proves to be unsuitable. However, this presupposes a user who already has his own knowledge of a desired result in the text.

In practice, it has been shown that in order to obtain ”good“ answers, the questions to ChatGPT must be asked very precisely and the data to which the questions refer must be as structured and limited in scope as possible.

Test model 2 was developed as a prototype application at the TH Lübeck. The main differences to test model 1 are that it enables a standardized procedure, fixed input fields for data and documents are available, exemplary criteria for module structuring are stored and optimized prompts define the process in advance. The individual system properties and process steps are shown in Figure 2, bottom left:

- Any module descriptions, regardless of the language (e.g. also Arabic) can be compared with the complete module catalogue of TH Lübeck, which is already structured in a vector database (Chroma). The module description to be analyzed is either entered as text in a corresponding text field or read into the application as a pdf file.

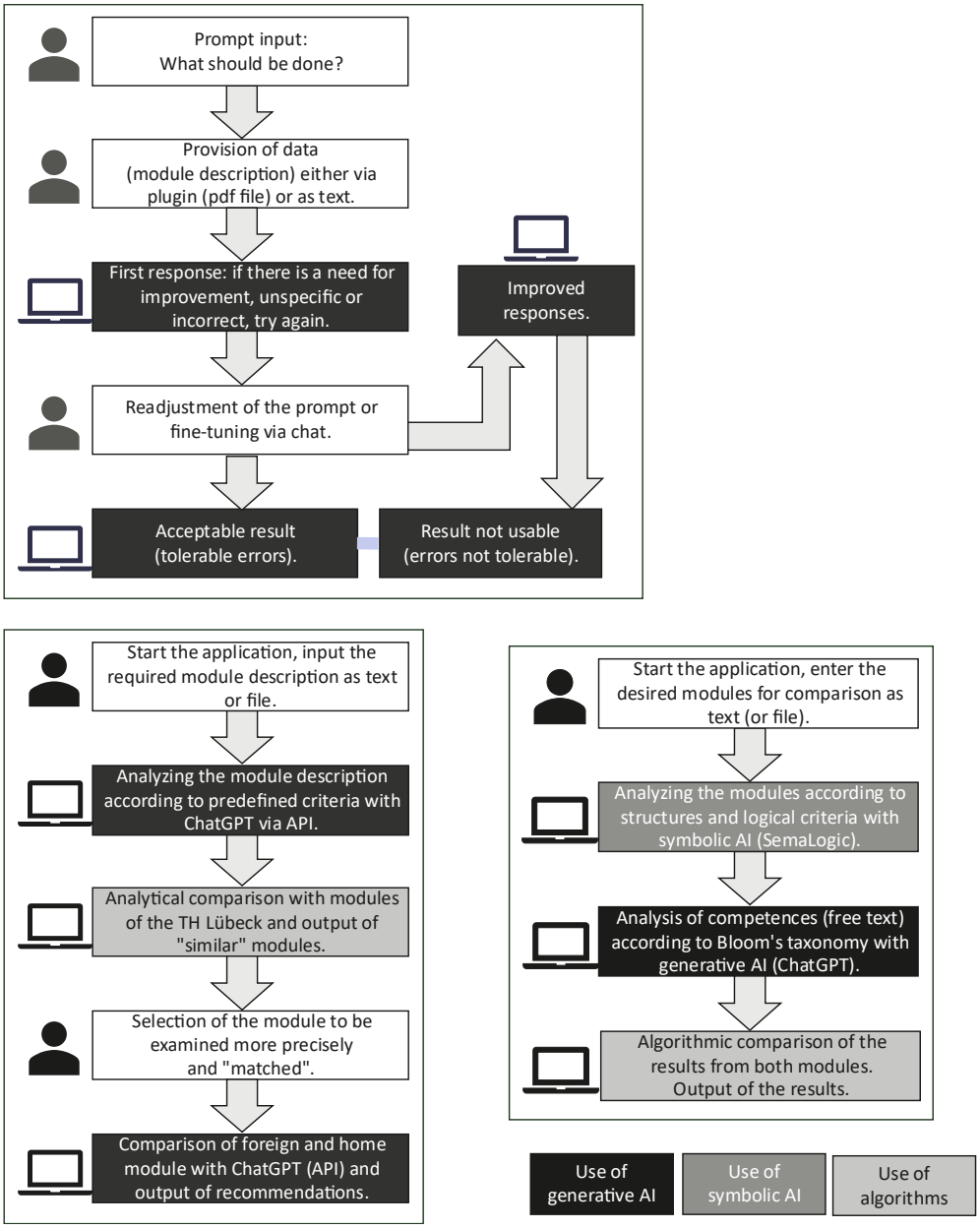

Figure 2: on top: Test model 1, single use of ChatGPT+ 4.0
Bottom left: Test model 2, fixed integration of ChatGPT+ 4.0-4 into a system application
Bottom right: Test model 3, combination of symbolic AI (SemaLogic) and generative AI (ChatGPT+ 4.0)
(Gilch et. al. 2024)

- The module description is then transferred to ChatGPT via an API interface, where it is analyzed and sorted into a predefined JSON data structure. ChatGPT sends the results back to the application and also writes them to the module database as a ”vector”.
- In the next step, an internal algorithm (purely analytical) compares the external module entered with the modules of the TH Lübeck and identifies the most similar modules for which the external module can possibly be recognized.
- Based on the selected criteria, ChatGPT then determines matches and deviations for a TH Lübeck module selected by the user and makes recommendations as to whether or not it should be recognized.

Generative AI, i.e. ChatGPT, is used here in a firmly structured form for clearly defined subtasks. This results in a high level of reproducibility in the responses and the application appears suitable in principle for docking onto other larger systems such as CaMS, MMS or PIM.

Finally, in test model 3, SemaLogic prototypically tested a combination of a symbolic approach with generative AI, which builds on many years of experience with the AI-based structuring of study and examination regulations (von der Heyde 2021a, 2021b, 2023a, 2023b) and applies this to module descriptions. This is a standardized procedure in which a symbolic AI is used to analyze module descriptions according to structures and logical criteria (components, credits, workloads, etc.) (see Figure 2, bottom right):

- In the first step, the modules to be compared are input as texts via an input mask or an API interface in SemaLogic® and structured and compared using this symbolic AI. The symbolic AI can easily process logical structures such as module structure and module components as well as quantifiable and structured content such as credits and workloads. An automatic analysis of free texts, e.g. the competences to be taught, quickly reaches its limits in view of the variety of possibilities.
- In order to analyze these and structure them according to Bloom’s taxonomy (HRK 2015) as an example, these free text fields are transferred to ChatGPT via API and optimized prompts, analyzed there and requested in table form as a response.
- The results from ChatGPT are then transferred directly back to SemaLogic and the modules to be compared are then compared algorithmically. Similarities and deviations can be output as results of the module comparison, provided the criteria for this are defined.

The use of generative AI is limited to the analysis of free text fields (e.g. for the competences to be achieved). Otherwise, only symbolic AI is used. So far, the application has only been tested in individual cases, but shows similar results for the same modules that were matched in test models 1 and 2.

To summarize, the results of the empirical tests for the AI Module Matcher application scenario provide a proof of concept that AI-based module comparison is already possible with the generative AI systems currently available. However, if the module comparison is carried out exclusively with ChatGPT and in unstructured form as in text model 1, there is great variability in the answers and the risk of fuzziness and hallucinations also increases with the complexity of the underlying data sets. However, if the generative AI is embedded in a professional application, as in test model 2 at TH Lübeck, the aforementioned risks cannot be completely avoided. However, it can be seen that very promising results can be achieved for both the textual structuring of the module comparison and for the assessment proposals with the containment of ChatGPT through formatting specifications and data preparation that promotes machine readability (vectorization). Targeted professional processing of the remaining weaknesses in the modelling, in particular through training with special data, feedback and

monitoring, in the direction of ”suitable and valid“ results of a module comparison could possibly further develop test model 2 so that it could be used for decision support. The comprehensibility of the results could be further increased if, as in test model 3, a formalized description language such as SemaLogic is also used, with which the semantic structures of the module descriptions can be algorithmically processed using similarity measures and the quantifiable data.

4 Summary and conclusion

The summary of the results of the various analyses shows that for all three application scenarios examined - AI Module Analyzer/Designer, AI Module Matcher and AI Chatbot - proof of concepts could be created, which indicate that these scenarios have great potential and could be used in practice in the near future.

Most of the universities surveyed are currently making efforts to develop AI-based chatbots, and the associated application possibilities are not limited to advising on recognition procedures or generally advising on university matters. At the same time, many companies see great potential in AI Chatbots to simultaneously improve their customer communication and save on personnel capacities. The empirical practical test conducted by HIS-HE in test model 1 exclusively with ChatGPT+ 4.0 for recognition counselling yielded only unsatisfactory results. The significance of this test appears to be reduced, as it is a completely independent, general AI system that was not designed or trained in any way for this specific application. Since AI Chatbots are also associated with great commercial potential, it is probably only a matter of time before such systems are available in better quality and could then also be used for the purposes of general student counselling. A semantic analysis of study regulations or module descriptions that understands the meaning of competencies and learning content, as should be used for counselling and decision-making in the context of recognition and credit transfer procedures, is not to be expected from systems based exclusively on generative AI in the foreseeable future.

The AI Module Analyzer/Designer and the AI Module Matcher are much more specifically oriented towards the respective applications. The two tools are linked because the practical tests have shown that analyzing and structuring module descriptions is a necessary prerequisite for digitally comparing modules and reliably identifying similarities and differences. In this respect, the AI Module Analyzer will be considered first. According to the experts interviewed, its great potential lies on the one hand in better structuring the large number of different formats and contents in the module descriptions according to uniform standards and thus making them more usable for other digital applications such as counselling. On the other hand, there is perhaps even greater potential in using an AI Module Analyzer as an AI Module Designer and using it when creating module descriptions. In this way, those responsible for modules can be supported in writing module descriptions and module handbooks and formulating the desired teaching content and competences to be taught relatively freely, but not arbitrarily, without having to deal intensively with standards, structures, taxonomies etc. themselves. The AI Module Designer would then suggest the structuring and semantic categorization of the module description so that users can adopt it more easily and enter it into the university’s module database. The manual effort required in curriculum design could be greatly reduced. A process based on symbolic AI is already being used at the University of Potsdam to map study and examination regulations from human language into digital formats so that they can then be used in the digital workflow in student and examination management (von der Heyde 2023a, 2023b). The semantic language SemaLogic used there was also successfully used in combination with ChatGPT+ 4.0 as generative AI in test model 3. Together with the results of test models 1 and 2 using ChatGPT alone, this shows that a combined approach with various algorithms - structured input of data, semantic analysis of module structure and module elements and generative analysis of free text - can be an effective tool that can be easily

integrated into corresponding management systems (SIS, MMS, DMS) thanks to the standards and interfaces already in use. The SIS of the universities could offer the existing data to all other educational institutions via standardized and externally open interfaces. If the modules and module descriptions were already structured and digitally retrievable at a later date, the use of an AI Module Analyzer would either be completely superfluous or greatly facilitated. However, if module descriptions from universities or degree programmes are available that have not already been structured and semantically classified in advance, the AI tool would be able to perform the analysis and structuring step downstream as an AI Module Analyzer in order to store the module data in corresponding module databases after validation by humans or to process it further with an AI Module Matcher, for example. As AI text generators and AI text analyzers also have a wide range of potential applications outside the university world (e.g. in contract creation and contract review in LegalTech), development here will certainly be driven forward on a broader level, so that AI Module Analyzers and AI Module Designers should also be ready for use in a few years' time.

The most controversially discussed application scenario is undoubtedly the AI Module Matcher, as this could ultimately not only prepare human decision-making on the recognition of modules, but possibly even replace it. The results of the empirical tests show that, in principle, an AI-based module comparison to identify similarities and differences is already possible. And it has also been shown that a combination of different algorithms delivers the most valid results. This also applies if the AI Module Matcher only provides the preparation of the documents and information on the basis of which a human then makes the decision. This preparation of information must be reliable so that the decisions based on it can be legally secure, transparent and comprehensible for those affected. If the results of the investigations are summarized, a hybrid approach could be a future solution for integrating recognition algorithms into digital workflows:

- Modules and achievements from universities with which contractual agreements on mutual recognition have been made in advance are identified directly in the workflow and automatically recognized. This also applies if corresponding information on previous decisions is already available in recognition databases. Even then, direct digital access to this data and therefore automated decision-making is possible. Preparation of the contractual agreement also requires an analysis of the existing degree programmes and could be based on one of the following solutions.

- If modules, module descriptions and all module content (including teaching content and competences) are available digitally according to uniform standards that also capture the level of meaning, this data can be exchanged between the universities and then compared with each other using appropriate algorithms. The use of generative AI then seems unnecessary, so that at best symbolic AI is used in expert systems. As their results are basically comprehensible and - provided the training is correct - also correct, they can be used reliably to prepare the decision-making process and thus relieve the responsible professors or their staff.

- If module descriptions and other documents are available (even partially) in unstructured form for decision-making or if important information such as the competences taught is written in prose, the information must be prepared using the AI Module Analyzer (see above) before algorithmic module matching. If possible, generative AI should only be used for clearly defined questions, for example for free text elements with very specific requirements, in order to minimize the risk of hallucinations and misjudgments. All module information that can be clearly quantified and analyzed should be processed with the help of expert systems, formal specification languages or algebraic methods.

The study has shown that it is fundamentally possible to use AI-based tools such as an AI Chatbot. AI Module Analyzer/Designer and AI Module Matcher - there is enormous potential associated with these tools, which makes their practical use at universities appear sensible. It is now necessary to deepen

the modelling described so far in the prototype laboratory and develop it into finished applications. The case studies show different strengths for further development: the application from TH Lübeck appears to offer suitable modelling for an AI Module Matcher and integration into the PIM project, while the combination of symbolic AI such as SemaLogic and generative AI such as ChatGPT offers the potential to analyses and specifically design the stringency of module manuals and module descriptions (AI Module Analyzer). With regard to a possible AI Chatbot, the current AI projects of USOS at the TU Berlin and AIStudyBuddy in the network of RWTH Aachen, RU Bochum and BU Wuppertal seem suitable for making the chat idea fruitful for dialogue-oriented student counselling and later transferable to recognition procedures due to their current adaptation to include generative AI in the project design. However, all three developments would require suitable organizational projects and substantial financial support as framework conditions.

Irrespective of the possible use of AI, the recognition processes should be further developed, simplified and digitalized using the existing possibilities (e.g. recognition databases, contractual agreements). This would also require an appropriately funded project to set up a digital recognition workflow at a university together with a CaMS, MMS and/or DMS manufacturer as an example. E.g. PIM (https://pim-plattform.de/) in Germany is such a project, in which many universities and CaMS providers are involved to build up a digital workflow for recognition processes. Prototypes of AI Module Analyzer, AI Module Matcher and AI Chatbot could then be integrated into this recognition workflow and tested and further optimized in practical use.

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