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Matching and Ranking Trustworthy Context-Dependent Universities:
A Case Study of the King Abdullah Scholarship Program

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ABSTRACT

The King Abdullah Scholarship Program was created in 2005 by sending Saudi students to study abroad. The program has a series of specific rules and it was found that due to the multitude of services the students can choose from, there is a great difficulty in finding the most suitable universities/programs/courses. Traditional manual selection requires students to visit every university website looking for their preferred courses. Some students prefer to talk to advisers and recruiters to get help. Students are not aware that those advisers and recruiters might have a financial interest to direct students to certain universities. Therefore, the risk of applying to the wrong institution is increased. Manually selecting what is best for each criterion is a tedious task, and, consequently, in this work the authors use an automated system to reach a plausible solution.

KEYWORDS

Architecture, Context-Aware, Service Ranking, Trustworthiness

INTRODUCTION

Due to the huge number of universities and the variety of their features, choosing the right university and programs is a difficult task that requires a significant investment of time. For example, the prospective postgraduate student searching for a university will find many available universities, all of them claiming to be the best. This is overwhelming, as there are just too many offers to read and compare. Usually, university selection is based on the nearest university or the position of the university of their interest in the ranking lists or what the student can afford. In addition, students need to make sure that their existing qualification will be recognized by the foreign university that they plan to apply to. At the same time, they have to search for a legitimate university that is accredited by their country.

Different students from different countries have different context information. Including the context in the system of ranking would improve the ranking list's relevance. For example, the ranking of a university should include whether the university in the list of accredited universities is in the student's country or not. To boost the relevance of a ranking list, important factors to consider are the context of universities and students, and the amount of study time. Through context awareness, an individualized ranking list could be provided for each student.

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To solve the problem of redundant universities with similar course features appearing at the top of the ranking list, trustworthiness has a key part to play in ranking and selecting the appropriate university, based on the preferences of students.

There are many websites that help students with searching and finding their courses, such as FindAMasters ("About FindAMasters.com," n.d.), Prospects ("Search postgraduate courses | Prospects. ac.uk," n.d.), CUG Course Chooser ("CUG Course Chooser," n.d.), QS Course Finder ("Business Courses, Degrees, Masters, MBAs QS Course Finder," n.d.) and U-Multirank ("U-Multirank | Universities compared. Your way.," n.d.). Although these websites provide searching by features, the search process is based on a matching process that acts as a filter. Therefore, it filters out all other options that do not exactly match a predefined value. Then the search results are sorted in ascending or descending order based on one feature, which is most of the time insufficient. In real life, there is no choice that meets all the student's preferences.

The King Abdullah Scholarship Program (KASP) was created in 2005 by sending Saudi students to the United States. KASP now is the largest scholarship program in Saudi Arabia's history. The scope of the scholarship program has been broadened to include a number of advanced countries like the United Kingdom, Australia, and Canada. As a result of this scholarship program, Saudi scholar students have obtained bachelors, masters, and doctorate degrees, as well as medical fellowships. The major of study that students are allowed to enroll in is chosen carefully by the Saudi Arabian Government and Ministry of Education (MoE), based on the perceived need of the country and the economy ("Saudi Cultural bureau in Canada," n.d.).

Although the MoE decides on the major that the students can choose from each university, it does not choose the course program for each student. An accredited list of universities is compiled for all available majors that the students can choose from, with wider alternatives. The accredited list of universities is subject to periodic review in order to meet the needs of the Saudi labor market ("ريفس ا ريفس - تاعماجلا نع ثحبب ةعماج," n.d.). It is the student's responsibility to search and find a suitable university and major from this list of accredited universities provided by the MoE. Students search themselves for the right courses. Now it is time to automate and facilitate the process of searching for the right courses and make it much easier than before.

The scholarship program KASP has a number of the restriction rules with regard to choosing universities and programs, despite the fact that the university is included in the accredited list ("ريفس ا ريفس - تاعماجلا نع ثحبب ةعماج," n.d.). Some of the restriction rules and conditions are: 1) Students are not permitted to enroll in programs designed specifically for international students; 2) Students are not permitted to enroll in part-time or distance learning programs. They must be a full-time student; 3) Students are not permitted to enroll in fast-track bachelor's degree programs; 4) Postgraduate students are not permitted to enroll in vocational programs or non-specialized programs. Due to time constraints and the difficulty of collecting data related to these conditions for each university and program, the authors restrict their work only to rule 2 above. Three types of students fall under the umbrella of KASP, and therefore the authors have three identities: 1) Scholar student: a student who studies abroad with a scholarship with complete funding; 2) Self-funded student: a student who is able to study abroad without a scholarship; 3) Scholar employment: a student for whom funding is covered by the employer.

Each identity has its own context and encompasses multiple features. For "scholar student," "identity," "fee," "mode of study" and "qualification" features will be hidden. Because the scholarship typically covers full academic fees and students are not permitted to enroll in certificate or diploma programs, part-time or online or distance-learning courses will be hidden. If the identity is "self-funded student," "fee," "mode of study" and "qualification" features will appear in the search.

The authors are not aware of any published study that investigates the abovementioned challenges of ranking and matching multiple features of universities and programs. This study aims to present a ranking solution that makes use of information about available services, matched with the applicant's needs and preferences.

LITERATURE REVIEW

Problem with Current Choosing Algorithm for Universities

There are many ranking systems for universities: Quacquarelli Symonds World University ranking QS, Shanghai ranking and national ranking systems (such as the Complete University Guide for UK universities, and Asia's Best Universities for Asian universities). The majority of students consider the position of the university of their interest in the ranking lists. However, the student should not count on these ranking systems as a guide for choosing a university and they should look for additional information before making a selection of institution, such as course details, accommodation, and fees. The traditional manual selection requires students to visit all the various university websites for the courses that they wish to apply for. Some students choose to approach recruiters and advisers for their assistance, not being aware that such assistance may be linked to a financial interest to steer students towards in particular directions. This increases the risk of applying to an institution that is inappropriate for the student.

Instead of this traditional manual selection, there are many search websites that help students with searching and finding their courses, such as FindAMasters ("About FindAMasters.com," n. d.), Prospects ("Search postgraduate courses | Prospects.ac.uk," n. d.), CUG Course Chooser ("CUG Course Chooser," n.d.) and QS Course Finder ("Business Courses, Degrees, Masters, MBAs QS Course Finder," n. d.).

In 2014, U-Multirank ("U-Multirank | Universities compared. Your way.," n. d.) launched their website as an interactive web tool that helps students to compare institutions with similar institutional profiles and allows them to develop personalized rankings by selecting preferences features.

Although these websites provide the facility to search by features, the search process is based on a matching process that acts a filter. Therefore, it filters out all other options that do not exactly match a predefined value. Then the search results are sorted in ascending or descending order based on one feature, which is most of the time insufficient. In real life, there is no choice that meets all the student's preferences. Therefore, there is a need for a ranking process that defines the best options. Students would appreciate a platform that allows them to consider when they are searching for a legitimate university accredited by their countries and which helps them to find the right university that recognizes their existing qualifications. No tool is presently available that takes account of the range of features of universities, including its context, trustworthiness and capabilities. This case study therefore aims to provide a ranking solution that draws on the information in the public domain about the universities' features, including its trustworthiness and context. This case study focuses on the King Abdullah Scholarship Program described in the following section.

METHODOLOGY

This section presents the proposed framework that aims to improve the relevance of trustworthy service ranking results by taking into consideration the contexts of the service requester and provider.

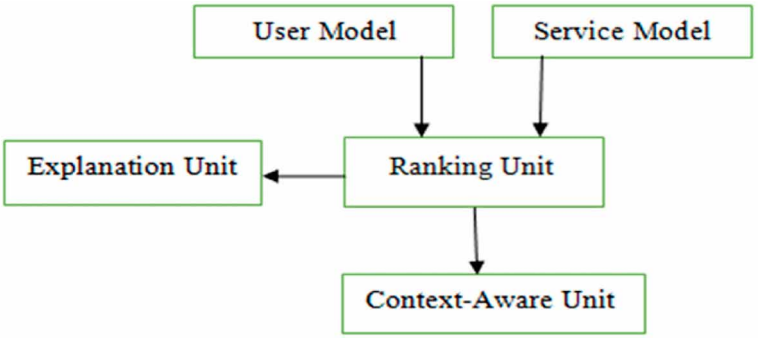
General Overview of the Proposed Framework Model

Figure 1 presents the fundamental components of the framework: service model, user model, ranking unit, context aware unit, and explanation unit.

The "User Model" is composed of three components: user personal information, dynamic information (may change over time, such as qualification, job, language requirement and skills) and user identification (holds more personalized data about the requester context which allows the system to better rank the services that fit the requester requirements). The user model is used to infer the context information and user preferences.

The "Service Model" consists of services and their features. A service provider prepares services and stores them in the service registry. Each service can be described by many features, which provide

Figure 1. Context-aware framework model



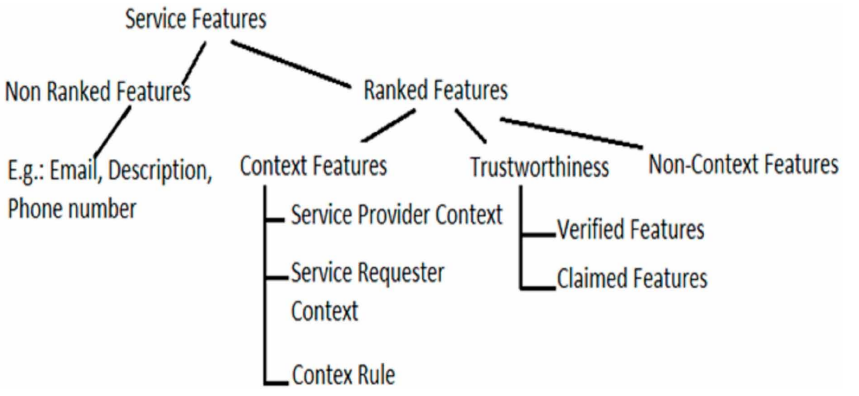
sufficient information that is unique to a service. Typical features of a service are functionality, price, and other properties that describe the qualitative and quantitative characteristics of the service. The set of features that are relevant for the application are domain dependent. These features are classified into two groups: ranked features and non-ranked features. Ranked features are features included as criteria in the ranking model. Non-ranked features store additional information and are not included as criteria in the ranking model (e.g. email, phone number, and links). The ranked features are categorized into three groups: context features, non-context features, and trustworthiness features. Figure 2 illustrates the classification of the services' features.

The "Ranking Unit" is a central processing component that is used to match and rank trustworthy context-depended services. It takes the queries and services as input and computes a matching score, using a similarity measure formula as stated in (Alsaig, 2013), and the way to treat and rank context features and trustworthiness features (Bawazir, 2016).

The "Context-Aware Unit" has two main components: a domain knowledge base and a reasoning engine. The domain knowledge base contains important facts about the service provider and the service requester. The reasoning engine is an intelligent component that provides context-based ranking using the domain knowledge base.

The "Explanation Unit" produces suitable explanations for the rankings of the results. For example, services can be grouped according to the data about their trustworthiness and about their context. Each group is labeled according to the characteristics of the services. For instance: "Services suit

Figure 2. Service's features classification



your context," "Trustworthy services suit your context," so that the service requester will be easily able to see why these particular services have been selected and how they relate to each other. As in (Pu, Chen, & Hu, 2012) the design guidelines for providing the explanations are described as follows.

"Consider explaining why the system recommends the suggested items. These aspects can be highly correlated to users' satisfaction, sense of control, and trust-inspired behavior intentions, such as the intention to save effort and the intention to return."

King Abdullah Scholarship Program

To evaluate the success of the architecture, the authors conducted different combinations of queries with different priority options and identities based on real world data. The case studies are implemented as a web-based platform using HTML, C#.net and ASP.net MVC 5. The data is stored in an SQL server 2014 using Entity Framework 6.1 for connecting and querying the database. For the matrix multiplication operation, the authors used a Lightweight fast matrix class in C#. By using the Bootstrap library, the author make it responsive to any browsing environment such as desktop, laptop, tablet, or smartphone.

To be able to apply our proposed architecture in any application domain, the authors have to understand the data in terms of 1) number of features, 2) potential data types and their semantics (More is Better MB, Less is Better LB and Exact is Better EB) and, 3) classification of the features into context, non-context and trustworthiness features. No dataset with all of the required features in universities' domains was available. Therefore, the authors had to collect raw data from different web pages. Data was extracted from the course guide chooser ("CUG Course Chooser," n. d.) supplied by UCAS. The data was organized in Comma-Separated Value (CSV) sheet format. Context information was extracted from the MoE for the Saudi scholar student. The features, their data types, and semantics are as follows:

- **Subject:** A string value describing the desired subject area of study (EB feature);
- **Program title:** A string value describing the main subject of the program (EB feature);
- **University:** A string value indicating the name of the university offering the program (EB feature);
- **City:** A string value indicating what the city of the university is (EB feature);
- **Duration:** An integer value indicating the number of years the student is expected to spend to complete the program. The duration is better as it decreases (LB feature);
- **Mode of study:** A string value indicating a preferred mode of study: full-time, part-time, or distance /online learning (EB feature);
- **Qualification:** A string value indicating a preferred degree program to study for a bachelor's degree, postgraduate (research/taught) (EB feature);
- **Entry qualifications:** A string value indicating students' qualifications that they should have prior to entering higher or further education (EB feature);
- **English requirement:** A numeric value indicating the level of English scores for students who do not have English as their first language. The English requirement is better as it decreases (LB feature);
- **Fee home student:** A numeric value indicating the cost of the program for the home student. The fee is better as it decreases (LB feature);
- **Fee oversees student:** A numeric value indicating the cost of the program for oversees student (LB feature);
- **Accredited universities:** A finite set of universities accredited based on users' countries (EB feature);
- **The program recognized by a different situation:** A string value describing the recognized certification (EB feature);
- **League table ranking:** A numeric value indicating the university's position in the league table in 2016 (domestic rankings table for UK universities). The rank is better as it decreases (LB feature);

- **Student satisfaction:** A numeric value indicating the feedback of the programs' students to assess the program course and university. Student satisfaction is better as it increases (MB feature);
- **Safety "crime statistics":** A numeric value indicating the best and worst universities and colleges for student-relevant crime that reflected a safety feature. The crime statistics are better as they decrease. Hence, it is considered as an LB feature. Safety includes a set of properties that indicate the crimes most relevant to students. It includes three sub-features: burglary, robbery, and violent crime (LB feature);
- **Burglary:** A numeric value indicating offenses where a person enters a house or other building with the intention of stealing (LB feature);
- **Robbery:** A numeric value indicating offenses where a person uses force or threat of force to steal (LB feature);
- **Violent crime:** A numeric value indicating offenses against the person, such as common assault, grievous bodily harm and sexual offenses (LB feature). Burglary, robbery and violent crime were as defined by the police ("Police.uk," n. d.).

Regarding unranked features, the authors included two features:

- **Program description:** A string value describing the program, so students can look at the specific details of the programs that interest them;
- **Email:** A string value describing the email address for the university, so students can get in touch with universities by email.

Table 1 illustrates the relationships between features and their categories, as well as between identities and their features.

For the sake of simplicity, the authors have included only 11 records ordered by the league table ranking 2016. The records shown in Tables 2 and 3 need to be ranked to show the benefits of our proposed framework. In addition, the authors considered the variables "Essential Accuracy" and "Algorithm Accuracy*"* to be preset to the values 0.01 and 0.1 respectively. In Table 2, the notation CS indicates "Computer Science" and in Table 3, the notation BCS indicates "British Computer Society".

CASE 1

"Identity" has been set to "scholar student" and "priority" has been set to "trustworthy context services" for the entire query. In this case, the authors demonstrate how Ahmad, a future postgraduate student, utilizes our framework to find the suitable institutions and course to apply to in the UK. He starts by building his profile and identifying his identity, as shown in Table 4. He submits the query, as in Table 5, where the title has significant weight and the duration is set to "best" mode. University and city features do not have considered weights, therefore, he is willing to accept any values for these features, and the priority is set to "trustworthy context services". The query for trustworthiness shown in Table 6, the rank is set to "exact" mode, and safety and student satisfaction are set to "best" mode.

From the user profile, the system can infer the list of accredited universities based on user nationality. From identity, it can define the set of features and context rules that relate to them. Since the user is a scholar student, the system inferences the following: 1) The mode of study will be full-time because they are not permitted to enroll in the part-time or online program. 2) The system can infer entry requirement from the student's qualification and predict the preferred qualification type. 3) The reasoning engine studies the correlation between two features: as the job here is teaching assistant, the preferred type will be master of research.

Table 1. The relationship between features, their categories and identities

Category	Identifier	
	Identity: Scholar Student, Scholar Employment	**Identity: Self-Funded Student**
Context Rule	Accredited universities, Entry qualifications, Qualification, and Mode of study	Accredited universities, Entry qualifications, and Qualification.
Service Requester context	English requirement and Type of qualification	English requirement and Type of qualification.
Service Provider context	-	Fee (home or overseas) student
Non- context feature	Subject, Program title, University, City and Duration	Subject, Program title, University, City, Duration and Mode of study.
Verified trustworthiness features	League Table Ranking, Program recognized by different situation, Safety	
Claimed trustworthiness features	Student satisfaction	
Unranked feature	Program description and email	

Table 2. The eleven services and their context and non-context features

Record No.	Title	University	Category	Duration	Mode of Study	Qualification	City	English Requirement	Fee	
									Home	Overseas Students
S1	CS	University of Cambridge	CS	4	Full-time	PhD	Paisley	-	£7,362	£23,889
S2	CS	University of Birmingham	CS	2	Part-time	MRes	Birmingham	6	£7,200	£19,200
S3	Advanced CS	University of Birmingham	CS	1	Full-time	MRes	Birmingham	6	£6,840	£17,960
S4	Advanced CS	University of Manchester	CS	1	Full-time	MRes	Manchester	7	-	-
S5	Computer Systems	Heriot-Watt	CS	3	Full-time	BSc	Edinburgh	-	£16420	£1820
S6	Network Systems Engineering	Plymouth University	CS	1	Full-time	MSc	Plymouth	6.5	£5,660	£13,250
S7	Advanced CS	University of Salford	CS	1	Full-time	MSc	Salford	6.5	£4,845	£13,050
S8	Computing Science	Staffordshire	Computer Information System	1	Full-time	MRes	Stoke	6	-	£11,500
S9	Networking and Data Communications	Kingston University	CS	1	Full-time	MSc	Kingston	6.0	£5,900	£12,500
S10	Computing	Bedfordshire	CS	1	Full-time	MRes	Luton	6	£3,996	-
S11	CS	Bedfordshire	CS	3	Full-time	MSc	Luton	6	£9,000	-

Table 3. The eleven services and their trustworthiness features

Record Number	Verified Features						Claimed Feature
	Rank	Professionally Recognized By	Safety Crime statistics			Safety Total Score	Student Satisfaction
			Burglary	Robbery	Violent Crime		
S1	1	-	7.02	0.49	14.03	21.54	4.18
S2	18	-	8.15	3.14	18.13	29.42	4.08
S3	18	-	8.15	3.14	18.13	29.42	4.08
S4	28	BCS	13.62	3.08	22.43	39.13	4.02
S5	37	-	-	-	-		4.09
S6	90	-	5.10	0.42	21.80	27.32	4.03
S7	96	-	12.60	3.09	23.44	39.14	3.93
S8	103	BCS	6.25	0.92	23.89	31.06	4.04
S9	104	-	7.51	0.81	13.46	21.78	3.90
S10	110	-	9.99	1.25	18.08	29.32	4.04
S11	110	-	9.99	1.25	18.08	29.32	3.89

Table 4. User profile for Ahmad

User Profile	
Name	Ahmad
Nationality	Saudi
Identity	√ KASP Scholar. Self-funded student. Scholar employment.
Qualification	Bachelor
Job	teaching assistant
English Requirement	6.5

Table 5. Query for non-context features for case 1

Query	Non-Context Features		
	Title	Category	Duration
Values	Computer Science	Computer Science	2
Weights	significant	normal	normal
Mode	EB	EB	BB
Range			
Key			
Priority	Trustworthy services, √ Trustworthy context services, Context services		

Table 6. Query for trustworthiness features for case 1

Trustworthiness Feature							
	Verified Features						Claimed Feature
Query	Rank	Professionally Recognized By	Burglary	Robbery	Violent Crime	Safety	Student Satisfaction
Values	20	BCS	10	2	12		4
Weights	normal	significant	low	normal	low	normal	normal
Mode	EB		BB	BB	BB		BB
Range							

In advance, during the design stage, the authors stated that the context features are set to essential features and both have insignificant weights, and the mode for the English requirement is set to "exact better". Table 7 shows the query for context features and context rules.

Firstly, the system applies the context rule, therefore S1 is excluded because S1 is a PhD degree and the student does not qualify to study for a PhD. S2 is also excluded because it is a part-time study, and scholar students are not permitted to enroll in part-time programs. S5 is excluded because it is a bachelor's degree and the student has a bachelor degree. The system infers that it is searching for a master's degree. S7 is excluded because its major is not in the list of accredited universities for a Saudi scholar.

Secondly, the rest of the services: S3, S4, S6, S8, S9, S10, and S11 are ranked based on context and non-context features, as shown in Table 8.

From Table 8, noting the first four services: S3, S8, S10 and S4, we found the context features were met and the service ranked based on the context features English requirement and qualification. Although S3 and S4 have the same title value, the algorithm preferred S3 over S4 because the semantic for the English requirement is LB. However, S4 has a greater value for the English requirement 7 than the defined value in the user profile 6.5. Therefore, the algorithm classifies those services into two groups: 1) The first group of services suits the context and includes all the services fulfilling the context information S3, S8 and S10. S4 is not included in the context group because its English requirement is greater than the user context. 2) The second group of services did not suit the context, and includes the rest of the services: S4, S6, S11 and S9. We notice the algorithm preferred S3 over S8 and S10 because the value of the title feature is "Computer Science". The value of the title feature is considered because its weight in the query has been set to "significant" and the weights of duration and category are set to "normal". Thus, the services are ranked based on context features and take into consideration the non-context features. If we look at the last three services, S6, S11 and S9, we find that the context feature qualification was not met. Although S11's title is

Table 7. Query for context features

Query	Context Features			
	Qualification	Preferred Qualification	Mode of Study	English Requirement
Values	Master	MRes	Full-time	6.5
Weights	CR	insignificant	CR	insignificant
Mode				EB
Range				

Table 8. Ranking the results based on context and non-context features case

Record No	Title	University	Category	Duration	Mode of Study	Qualification	City	English Requirement	Ranking Score
Services suit the context									
S3	Advanced Computer Science	University of Birmingham	Computer Science	1	Full-time	MRes	Birmingham	6	0.809222288
S8	Computing Science	Staffordshire	Computer information system	1	Full-time	MRes	Stoke	6	0.807722288
S10	Computing	Bedfordshire	Computer Science	1	Full-time	MRes	Luton	6	0.806722288
Services did not suit the context									
S4	Advanced Computer Science	The University of Manchester	Computer Science	1	Full-time	MRes	Manchester	7	0.808363008
S6	Network Systems Engineering	Plymouth University	Computer Science	1	Full-time	MSc	Plymouth	6.5	0.4375756
S11	Computer Science	Bedfordshire	Computer Science	3	Full-time	MSc	Luton	6	0.378148688
S9	Networking and Data Communications	Kingston University	Computer Science	1	Full-time	MSc	Kingston	6.0	0.377082288

"Computer Science", the algorithm preferred S6 over S11 because the value of the English requirement feature was met exactly as defined in the user profile. Therefore, S11 is preferred to S9 because of its title value. Thus, when context features were not met, the services were ranked based on non-context features.

Finally, the results were re-ranked based on trustworthiness features. In this step, we ranked the services in each group based on trustworthiness features separately.

From Table 9 we noted the following: S8 is ranked higher because it is professionally recognized by the British Computer Society and the student gave it a significant weight. Regarding the safety feature, the user gave the highest weight to the robbery feature, and S8 has a lower robbery value than S3. Although S10 has a lower robbery value than S3, the algorithm prefers S3 over S10, since the weight for the whole safety feature has been set to normal to compare it with other features. S3 has a better rank and higher student satisfaction value than S10. Thus, when one sub-feature is met, the weight for the whole composite feature is taken into consideration to make a comparison with other non-composite or composite features.

CASE 2

Case 2 is characterized by the identity set to "scholar student" and the priority to "trustworthy". In this example, we consider the same user profile shown in Table 4 and the same query for not-context and trustworthiness shown in Tables 5 and 6 respectively, with the priority option set to "trustworthy services". The context information does not change and it is the same as in Table 7. After applying

Table 9. Re-rank the results based on trustworthiness features for case 1

Record Number	Verified Features						Claimed Feature	Ranking Score
	Rank	Professionally Recognized By	Safety Crime statistics			Safety Total Score	Student Satisfaction	
			Burglary	Robbery	Violent Crime			
Trustworthy- context Services								
S8	103	BCS	6.25	0.92	23.89	31.06	4.04	0.00219008328417
S3	18	-	8.15	3.14	18.13	29.42	4.08	-0.007432314815
S10	110	-	9.99	1.25	18.08	29.32	4.04	-0.011789375
Trustworthy services did not suit the context								
S4	28	BCS	13.62	3.08	22.43	39.13	4.02	0.00639082262
S6	90	-	5.10	0.42	21.80	27.32	4.03	-0.011543293524
S9	104	-	7.51	0.81	13.46	21.78	3.90	-0.01172909357
S11	110	-	9.99	1.25	18.08	29.32	3.89	-0.01179684201

the context rule, as in case 1, the results are ranked based on trustworthiness features, as shown in Table 10. The algorithm skips the step of ranking the result based on context and non-context features because the priority has been set to "trustworthy services".

Notice the change from the result of case 1 in Table 9 to Table 10. The main reason is because S4 and S8 are closer to the user request from the perspective of trustworthiness features. S4 did not suit the user context in terms of the English requirement feature, since it has a greater value than the query value. Thus, when the "trustworthy services" priority is on, the algorithm ranks the services that met the context rule based on trustworthiness features, and it uses the "trustworthy services" label to define them. The trustworthiness features take precedence over context features.

Table 10. Rank the results based on trustworthiness features for case 2

Record Number	Verified Features						Claimed Feature	Ranking Scores
	Rank	Professionally Recognized By	Safety Crime statistics			Safety Total Score	Student Satisfaction	
			Burglary	Robbery	Violent Crime			
Trustworthy - Services								
S4	28	BCS	13.62	3.08	22.43	39.13	4.02	0.00639082262
S8	103	BCS	6.25	0.92	23.89	31.06	4.04	0.00219008328417
S3	18	-	8.15	3.14	18.13	29.42	4.08	-0.007432314815
S6	90	-	5.10	0.42	21.80	27.32	4.03	-0.011543293524
S9	104	-	7.51	0.81	13.46	21.78	3.90	-0.01172909357
S10	110	-	9.99	1.25	18.08	29.32	4.04	-0.011789375
S11	110	-	9.99	1.25	18.08	29.32	3.89	-0.01179684201

CASE 3

Case 3 is characterized by: identity is "self-funded student" and the priority is set to "trustworthy context services". The type of qualification is set as a key feature. The fee and duration are set to "best" mode. The query for non-context features is shown in Table 11. The query for trustworthiness is shown in Table 12. The rank is set to exact mode, safety is set as a whole feature and student satisfaction is set to "best" mode. The rank is applied to S1, S2, S3, S5, S6, S7, S8 and S9 because they have an available value for the fee feature.

Remark: the algorithm has the ability to deal with missing features and null values but for the sake of simplicity, we omit the services that have a null overseas fee.

From the user profile defined in Table 13, the system can infer the list of accredited universities based on user nationality. For identity, it can define the set of features and context rules that relate to the user. Since the student is a self-funded student, the mode of study and fee appear. Also, the system can infer the entry requirement from the student's qualification and predict the qualification type. Table 14 shows the query for context features and context rules. The context features are set to "essential features" and have an insignificant weight, and the mode for English requirement is set to "exact better".

Initially, the system applies context rules. Therefore, S1 is excluded because S1 is a PhD degree and the student does not qualify to study for a PhD. S5 is excluded because it is a bachelor's degree and the student has a bachelor's degree and he is searching for a master's degree. S7 is excluded because its major is not in the list of accredited universities for Saudi scholars.

Then the system applies the service provider context for the fee feature. Since the student nationality is Saudi, the fee for overseas students will be selected.

Table 11. Query for non-context features for case 3

Query	Non-Context Features					
	Title	**Category**	**Duration**	**Qualification**	**Mode of study**	**Fee**
Values	CS	CS	2	MRes	Full-time	£12,500
Weights	low	low	normal	normal	normal	significant
Mode	EB	EB	BB	EB	EB	BB
Range						
Key				√		
Priority	Trustworthy services, √ Trustworthy context services, Context services					

Table 12. Query for trustworthiness features for case 3

Query	Trustworthiness Feature			
	Verified Features			Claimed Feature
	Rank	**Professionally Recognized By**	**Safety**	**Student Satisfaction**
Values	20	BCS	25	4
Weights	normal	significant	normal	normal
Mode	EB		BB	BB
Range				

Table 13. User profile for case 3

User Profile	
Name	Ahmad
Nationality	Saudi
Identity	KASP Scholar. √ Self-funded student. Scholar employment.
Qualification	Bachelor
Job	-
English Requirement	6.5

Table 14. Query for context features for case 3

Query	Context Features	
	Qualification	English Requirement
Values	Master	6.5
Weights	CR	insignificant
Mode		EB
Range		
Essential		√

Secondly, the rest of services: S1, S2, S3, S6 and S9 are ranked based on context and non-context features.

By using a key feature, we notice the following: the algorithm excluded all the services that do not satisfy the context features and key features at the top. S6 has a higher ranking score because the English requirement met exactly the student context but it did not fulfill the key feature MRes qualification type. In Table 15, S8, S3 and S2 satisfied the user context and key feature, therefore they are grouped in one list with the label "results suit the context and key". Since S6 did not satisfy the key feature, the algorithm removed it from the first group and ranked it as a first service in the second group with the label "different results suit your context". Thus, we do not lose the original ranking score. By using labels, we help the student to make a better decision and faster. Finally, the services in each group were re-ranked based on trustworthiness, with the overall scores as in Table 16.

From Table 16, we noted the following: 1) All the services in the first group that are identified by "trustworthy services suit the context and key" are the same services in Table 15 that are identified by "services suit the context and key" but here are ranked based on trustworthiness features. Relative to the requested query in Table 16, we notice S3 and S2 are raised, and they have the same trustworthiness score = 0.69508445. However, the priority for ranking higher has been given to the service that has a higher score based on context and non-context features. Back to Table 15, S3 = 7.69624495 and S2 = 7.690859855. Thus, S3 ranked higher than S2. In this example, we notice how the trustworthy-context services priority affected the ranking, and how this priority sometimes comes at the cost of others. That is because the student set the fee as a significant feature but he gave the priority to trustworthy-context services.

S3 and S2 are the most trustworthy services but they have a higher fee than S8, and higher than the value set in the query. All the services in the second list identified by "different trustworthy services suit the context" are the same services in Table 15 identified by "different services suit your context" but here are ranked based on trustworthiness features. Therefore, we found here all the services in this

list suit the user context and trustworthy services but did not satisfy the key feature. We noted that S9 becomes the first service in this group because S9 is more trustworthy than S6 and it has a lower fee than S6. That means that the priority does not always come at the cost of other features; sometimes it helps to place each service in its specific place relative to the requested features.

Table 15. Re-ranking the results based on key feature for case 3

Rank	Record No	Title	University	Category	Duration	Mode of Study	Qualification	City	English Requirement	Fee	Ranking Score
										Overseas Students	
Services suit the context and key											
2	S8	CS	Staffordshire	Computer Information System	1	Full-time	MRes	Stoke	6	£11,500	7.69952033
3	S3	Advanced CS	University of Birmingham	CS	1	Full-time	MRes	Birmingham	6	£17,960	7.69624495
5	S2	Advanced CS	University of Birmingham	CS	2	Part-time	MRes	Birmingham	6	£19,200	7.690859855
Different services suit your context											
1	S6	Network Systems Engineering	Plymouth University	CS	1	Full-time	MSc	Plymouth	6.5	£13,250	8.95406956
4	S9	Networking and Data Communications	Kingston University	CS	1	Full-time	MSc	Kingston	6.0	£12,500	7.69578504

Table 16. Re-rank the results based on trustworthiness features for case 3

Record No	Verified Features						Claimed Feature	Ranking Score
	Rank	Professionally Recognized By	Safety Crime Statistics			Safety	Student Satisfaction	
			Burglary	Robbery	Violent Crime			
Trustworthy services suit the context and key								
S3	18	-	8.15	3.14	18.13	29.42	4.08	0.69508445
S2	18	-	8.15	3.14	18.13	29.42	4.08	0.69508445
S8	103	BCS	6.25	0.92	23.89	31.06	4.04	0.00398959497
Different trustworthy services suit the context								
S9	104	-	7.51	0.81	13.46	21.78	3.90	-0.00853927559
S6	90	-	5.10	0.42	21.80	27.32	4.03	-0.00907452885

CONCLUSION AND FUTURE WORK

In this paper, a full implementation of a case study of the KASP is presented. The authors conducted different combinations of queries with different priority options and identities. The results produced were satisfactory and expected. This implementation shows and proves the success of the proposed architecture. It was the first work to automate and facilitate the process of searching for the right courses based on context information and trustworthiness.

The authors intend as a next step to make automatic the selection of the features of services. At the moment, domain experts select features and assign semantics to them. The authors will make it possible for the descriptions of features to be selected automatically, converted into well-defined features and assigned semantics. The authors will also consider the automatic gathering of information about context, information that changes over time and is gathered from a variety of websites. It will be necessary to investigate whether such changes in context information can be detected and updated automatically.

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