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Recommendation Engine

imc Learning Suite

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Author(s): Daniel Dahrendorf
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imc
information multimedia communication AG
Headquarter Saarbrücken
Scheer Tower, Uni-Campus Nord
D-66123 Saarbrücken
T. +49 681 9476-0 | Fax -530
info@im-c.com
im-c.com

Content

1 Automated Recommendations

1.1 Information considered for recommendations

The system looks at the following information about a user: His or her **courses** and his or her **interests.**

Courses

In order for recommendations based on courses to be provided, the learner must already have courses assigned to him.

Interests

In order for the interests to be considered, the learner must fill in some input in the Interests (Personal attribute with Id 71) field of his user profile**.** The interests will be mapped to classifications of courses and media.

1.2 Default wokflow

Assigned courses	Failed courses	Interests	Outcome	Tuning via Panel configuration
Yes	Yes	Yes	Recommendations based on Failed courses and the learner's interests	Specify the type of content that should be recommended by using:"?type=<typeId>" ex: type=48 will only return Links
Yes	No	Yes	Recommendation based on the assigned courses and the learner's interests	Specify which course status to be taken into account by using "?bs=<booking state id" ex: ?bs=9 will take into account only the courses which are currently in progress when searching for recommendations
Yes	Yes	No	Recommendations based on Failed courses	
Yes	No	No	Recommendations based on assigned courses	Specify which course status to be taken into account by using "?bs=<booking state id" Weights can be used to specify which information is more important: ex: `recf=title^5&recf=description^1.7`
No	No	Yes	Recommendations based on the learner's interests	Specify which content type to be recommended by using "?type=<typeId>"
No	No	No	Recommendations based on popular courses if available, otherwise random recommendations The popularity is determined by the **number of booked users for courses** or by the **number of users who added a certain media item to their bookshelf**	Weights can be used to specify which information is more important: ex:`recf=bookedPersons^55&recf=bookshelfPersons^3`

2 Recommender system – technical details

The recommender system is implemented as a Apache Solr extension. Architecturally, it provides a new Apache Solr request handler (and thus a URL) that can be used as a REST web service. This request handler works in combination of the ACLTransformer search component, that filters out resources for which the users does not have access rights.
This document describes the URL parameters of the recommender system the different recommendation strategies and how they can be configured via URL parameters.

2.1 The URL parameters

The following URL parameters are allowed:

- **`rows`:** Sets the maximum number of items that should be returned by the recommender system. In case there are not enough matching resources a lower number than `rows` could be returned.
- **`user`:** The ID number of the user for which resources should be recommended.
- **`type` (multi-value):** A list of resource type IDs to filter out unwanted media types. The resource type is the mainTypeId field in the Apache Solr index.
- **`bs` (multi-value):** A list of booking state IDs that can be used to customize the *CourseRecommendationStrategy* (see below). These are the stati used in the `bookedPersons` field in Apache Solr.
- **`recf` (multi-value):** A list of fields used by the recommender system to do matching. The fields of different strategies can be used configured here. Most importantly, each field can have a weight (a floating point number) to boost the importance of this field in the ordering. The notation to append weights to fields is the standard Apache Solr notation, namely using an 'accent circonflexe', ^. For example, "`title^5 description^1.7`". To enter multiple values in the `recf` field, one can also just use a space (not valid for other multi-valued fields).
- **`interest` (multi-value):** A list of interest IDs or interest strings is used to feed the *InterestRecommendationStrategy* & *InterestAndCourseRecommendationStrategy*. This is mapped on the `classificationIds` and `classificationLabels` field in the Apache Solr index.
- **`aclPerson` (aclPersons) (multi-value):** The ACL person field is provided by the ACL Transformer search component.
- **`clientId` (aclClients) (multi-value):** The ACL client field is provided by the ACL Transformer search component.
- **`groupId` (aclGroups) (multi-value):** The ACL group field is provided by the ACL Transformer search component.

Note: None of the URL parameters are required. However, some strategies require some URL parameters. For instance, if no user is given than the *CourseRecommendationStrategy* will not be used.
Note: In case the URL gets too long due to browser size limits for an HTTP GET request, one can also use a POST request, with the URL parameters in the body.

2.2 The recommendation strategies

The recommender system uses different strategies to try to ensure that in all cases items are recommended. The flow chart below details the conditions to select the different recommendation strategies.

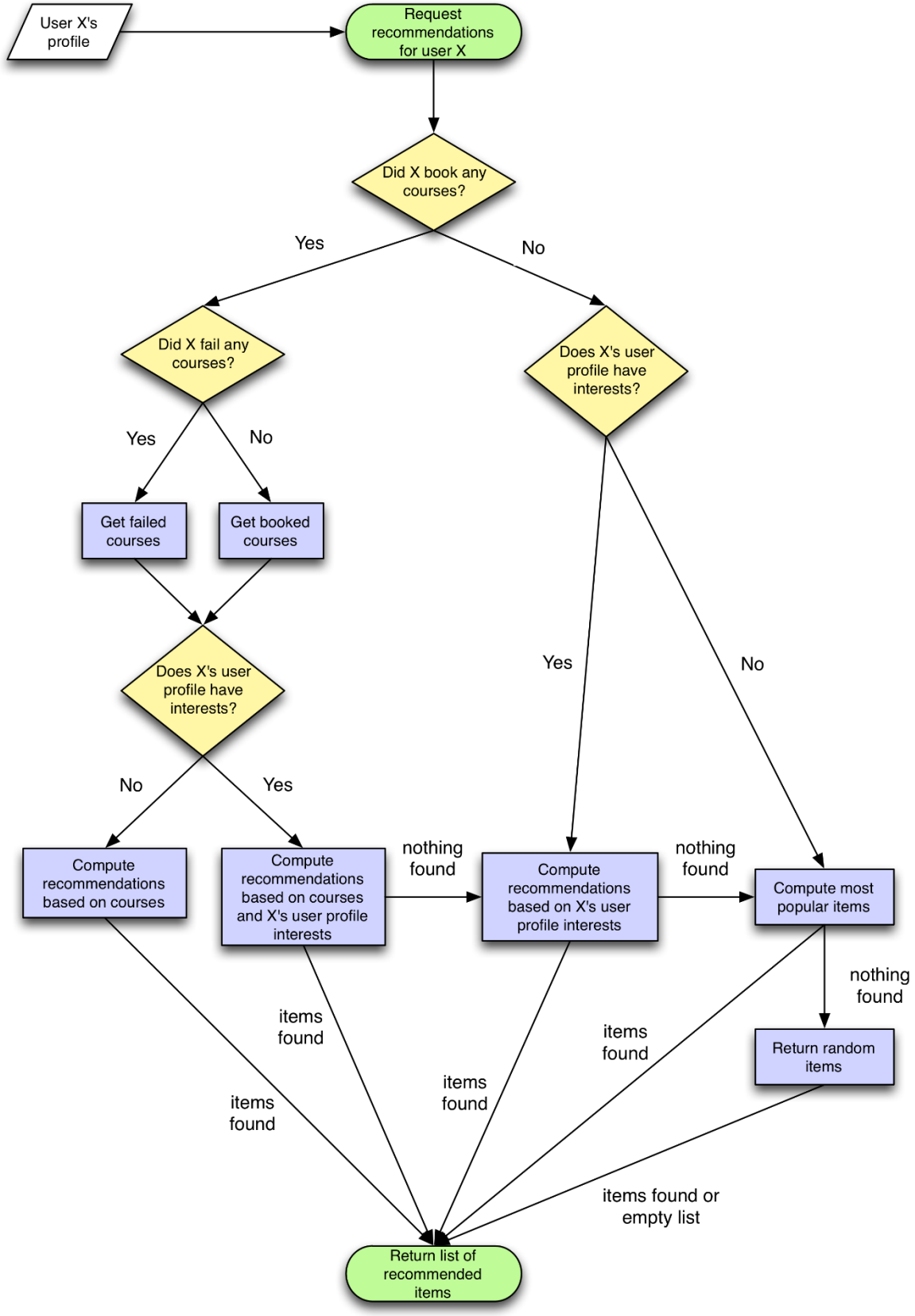

Fig. 2.1: Recommender flow chart.

The order of the recommendation strategies can be changed by editing the `de.imc.recommender.solr.handlers.recommender.builder.queue.PriorityRSQueueBuilder` or implement a new `de.imc.recommender.solr.handlers.recommender.builder.queue.RecommendationStrategyQueueBuilder`. Below, the different strategies are discussed, as well as the ways how each strategy can be tuned.

2.2.1 CourseRecommendationStrategy

The course recommendation strategy uses the user ID to find all courses that that user has booked. Then all the `searchText` fields of all courses are concatenated and used as text to get similar documents using the MoreLikeThis Solr functionality.
This strategy is used in two different flavours, one is configured to query the booked courses where the user failed, did not complete or quit the course (stati: REFUSED=5, WAITING=6, CANCELLED=7, DELETE=13, FAILED=12, NOT_SUCCESSFULLY_COMPLETED=21). And another strategy is configured to query the booked courses that the user completed succesfully (stati: SELECTED=1, AGREED=3, BOOKED=8, STARTED=9, FINISHED=10, PASSED=11, NOT_EVALUATED=14, UNBLOCKED=15, PREBOOKED=16, INDIVIDUAL_LEARNING_PLAN=17, RESERVED_ON_PARTICIPANT_LIST=18, RESERVED_ON_WAITING_LIST=19, SUCCESSFULLY_COMPLETED=20).

Required URL parameters:

- `user`

Tuning:
If you want to change these stati, you can pass your preferred stati via the URL parameters (use a `bs` parameter for each status id). When `bs` parameters are passed, a single *CourseRecommendationStrategy* is added to the queue (the failed and successful course strategies are not used).
You can also tune the boost weights to change the order of the recommendations, by using the `recf` parameter with a weight on the following fields: `title` and `description`.

2.2.2 InterestRecommendationStrategy

The interest recommendation strategy will find courses and media that have the same interest id (the `classificationIds` field in the Solr index is used) or will do a textual match using the interest strings (taking the `classificationLabels` field in the Solr index). The interest ids or strings should be passed via the URL via the `interest` parameter. If there is one ID (a slash separated numerical pattern, like this 000/000/000), it will use the ID matching because it is more precise. However, the string matching will probably bring up more varied recommendations.

Required URL parameters:

- `interest`

In order to have content recommended based on interests for a learner, the **Interest** personal attribute must be available in the user profile where the learner can input their interests. Based on the values available there, the mapping will be done for content that has matching classification values.

2.2.3 InterestAndCourseRecommendationStrategy

This strategy combines the interest and course data. The course data as used in the same way as the *CourseRecommendationStrategy*, namely all course descriptions and titles are concatenated and used in a MoreLikeThis query. The interest data is used in a similar manner as in the *InterestRecommendationStrategy*. The main advantage of this strategy is that the importance of the course data and interest data can be weighted, using the `recf` parameter.
Again, two of these strategies are added by default to the queue, one with successful booking states and one with failed states. One can provide specific booking states as in the *CourseRecommendationStrategy* (see tuning).

Required URL parameters:

- `user`
- `interest`

Tuning:
If you want to change the booking stati, you can pass your preferred stati via the URL parameters (use a `bs` parameter for each status id). When `bs` parameters are passed, a single *InterestAndCourseRecommendationStrategy* is added to the queue (the failed and successful strategies are not used).
You can also tune the boost weights to change the order of the recommendations, by using the `recf` parameter with a weight on the following fields: `title, description, classificationIds, classificationLabels.`

2.2.4 PopularityRecommendationStrategy

The popularity strategy aims to return the most popular items based on whether users have booked the course or put the resources on their bookshelf. This strategy should be the fallback option if no other strategies can return results. It will fail if the system is freshly set up, where no courses are booked yet and all bookshelfs are empty.
To get the popular items, a facet query is done to get all booked persons user IDs and another facet query is done to get all user IDs who have items on their bookshelf. Then a query is done to get the courses that match any of the collected booked persons user IDs, or any resource matching any of the bookshelf user IDs. Thanks to Apache Solr's ordering algorithms, the documents where more matches occur will rank higher, which results in a popularity ordering.
Note: The strategy might not provided the most popular items first, but it will be an approximation. This is due to the performance tuning of Apache Solr, which sets a maximum number of boolean clauses. If this maximum is reached, the left-over user IDs will not be appended to the query, so we might lose some accuracy. If a perfect popularity is wanted, an extra field could be added to the index that contains the number of booked persons and how many times the document appears on a bookshelf. The additional benefit would be a faster performance for this strategy, because only one query should be executed.

Required URL parameters:

- (None)

Tuning:
This strategy can be tuned to change the amount of recommended courses versus media. This can be done using the `recf` field with the `bookedPersons` and `bookshelfPersons`, e.g. `recf=bookedPersons^55&recf=bookshelfPersons^3`.
The default weights are for `bookedPersons`: 10 and for `bookshelfPersons`: 1. However this can differ depending on the content of the Solr index. If more courses are available and less media, the weights might need to be tuned.

2.2.5 RandomRecommendationStrategy

The random strategy is a last resort strategy. If no other strategy has returned results, the random strategy will be used. This strategy just returns the results if you query Apache Solr with a wildcard (i.e. `*:*`).

Required URL parameters:

- (None)

Tuning:

- (None)

2.3 Using recommendations in ILP

As the recommendation engine is based on the Solr catalog index, the catalog panel can be used to display recommended learning material for users.

2.3.1 Basic configuration of the catalog panel

A catalog panel can easily be configured to display recommended learning material for the currently logged in user. First, you duplicate an existing catalog panel and enter the following basic settings:

- In the "Catalog search for the Learning Portal" field: enter the term "`recommender`" or `recommender?type=3&type=43&type=45&type=48&type=84` (the content types might need to be provided).
- Choose with the "Number of shown contents" how many items should be displayed on the panel (this corresponds to the "`rows`" URL parameter described above).
- Choose one of the three layouts available to specify in which way the content should be displayed on the panel.
- Provide a name (displayed in the ILS backend) and title (displayed on the ILP dashboard) for the pane.
- Optionally, provide a description (displayed in the ILS backend) and infotext (displayed on the ILP dashboard) for the panel.

As a result, the catalogue panel in ILP will use the recommendation engine instead of the catalogue search.

The `user` parameter together with the `userId` of the currently logged in user is appended to the URL automatically by the panel, so it must not be added as a parameter here.

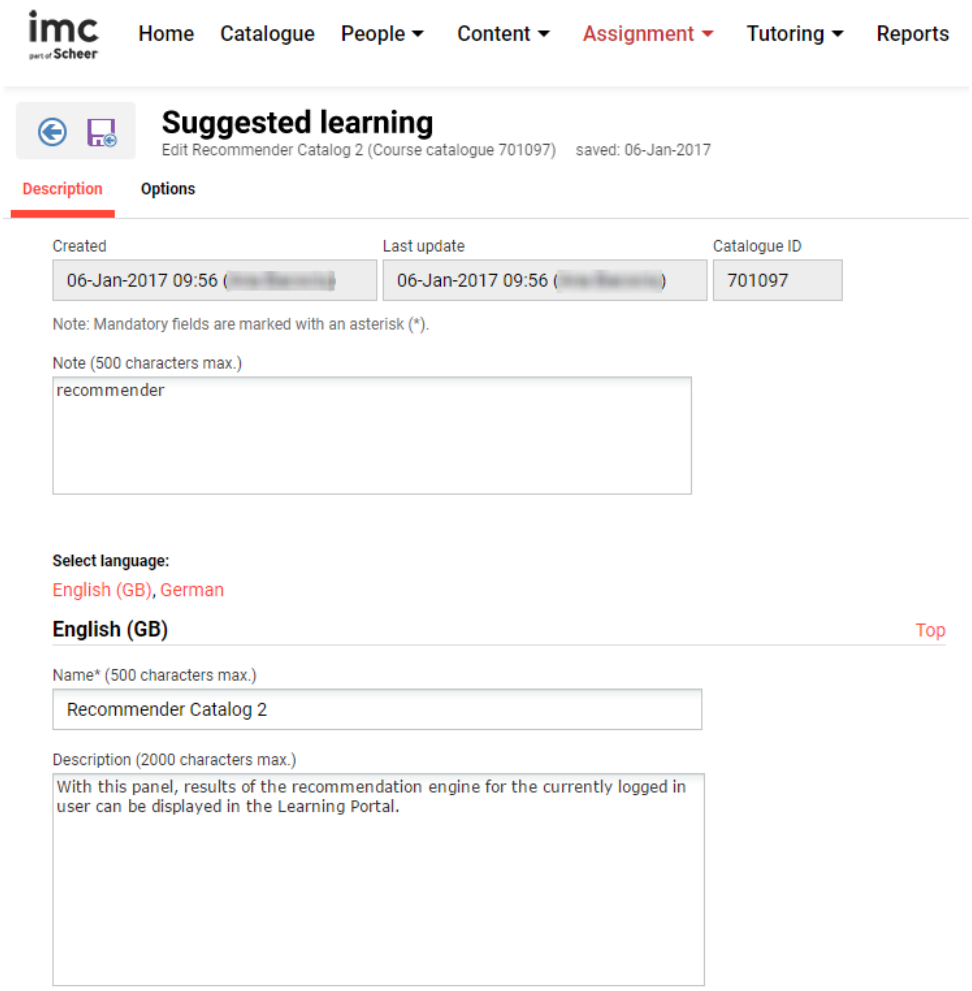

Fig. 2.2: Recommender panel configuration.

Afterwards, the panel must be added to the dashboard as the internal dashboard of ILP. As a consequence, the content recommended by the recommendation engine for the currently logged in user is displayed on the corresponding panel on the dashboard:

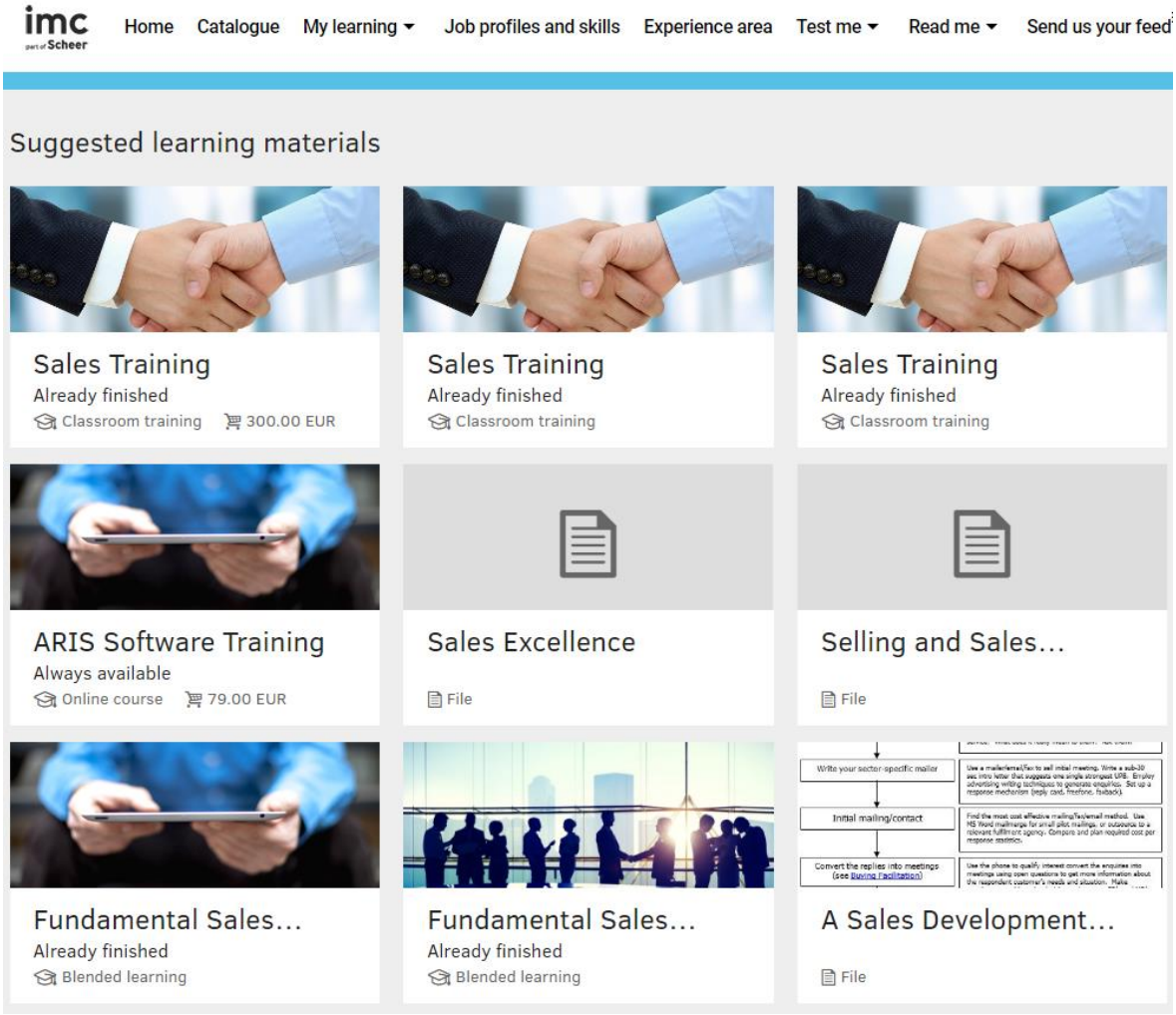

Fig. 2.3: Suggested learning panel.

2.3.2 Advanced configuration

The catalog panel configuration can also be used to fine-tune the recommender according to the options described above. All of the URL parameters described above can be used by adding them to the "recommender" string in the "Catalogue search for the Learning Portal" field. For example, if you want to configure the recommendation engine to only recommend courses based on a user's courses which he has currently started, you need to put the following in the field:

```
recommender?type=3&bs=9
```

Possible values for the "type" parameter

The "type" parameter maps to the `mainTypeId` field in Solr, which corresponds to a content type.

mainTypeId	Content type
3	Course
43	File
45	WBT
48	Link
84	Media File

Possible values for the "bs" parameter

With the "bs" parameter, it is possible to define the booking states of users and courses to be taken into consideration for the recommendations.

Booking state ID	Course booking state
0	IN_PROCESS
1	SELECTED
2	ORDERED
3	AGREED
4	NOTIFIED
5	REFUSED
6	WAITING
7	CANCELLED
8	BOOKED
9	STARTED
10	FINISHED
11	PASSED
12	FAILED
13	DELETE
14	NOT_EVALUATED
15	UNBLOCKED
16	PREBOOKED

Booking state ID	Course booking state
17	INDIVIDUAL_LEARNING_PLAN
18	RESERVED_ON_PARTICIPANT_LIST
19	RESERVED_ON_WAITING_LIST
20	SUCCESSFULLY_COMPLETED
21	NOT_SUCCESSFULLY_COMPLETED

Test cases

How to create the Recommender Panel:

#	Step actions	Expected results
1	Login to ILS with imc_super Navigate to Dashboard administration > Panels and search for Panel Catalogue panel (ILP) (171). Duplicate that Panel.	Panel can be duplicated.
2	Set the following: – for "Catalogue search for the Learning Portal" put "recommender" – for number of shown contents: 10 – set a name and title for the panel and Save and Close.	Panel was successfully created.
3	Navigate to Dashboard administration > Dashboard pages Search and edit dashboard Internal dashboard page (ILP) (7).	
4	On Contents tab add the recommender panel you just created > Save and close.	Panel was added to the dashboard.
5	Select the dashboard Internal dashboard page (ILP) (7) and Edit Clearences.	For the panel to be visible you must add the client/user with Execute rights.

How to use the course recommendation strategy:

#	Step actions	Expected results
1	Login to ILS with user imc_admin and navigate to Dashboard administration > Panels. Edit the "Recommended for you" panel and check if the following settings are available: – for "Catalogue search for the Learning Portal" : recommender – for "Number of shown contents" select 10 – for "Display option for learning portal" select One tile per row Save and close.	Recommended panel was successfully saved.
2	Go to Dashboard administration > search for Internal dashboard page (ILP) (7) and edit it. Go to tap Contents and add the "Recommended for you" panel to the Column that is in use (Always visible and Expanded). Save and close.	Recommended panel can be added to the dashboard page.
3	Go to Dashboard administration > select the Internal dashboard page (ILP) (7) and Edit clearences Add user "recommend1" with Execute rights. Save and close.	User can Execute rights on the dashboard page,
4	Login to ILP with user "recommend1".	Login is possible. Recommended for you panel is available on the dashboard. Recommended for you panel displays 10 contents.
5	Login to ILS with user imc_admin and navigate to Dashboard administration > Panels. Edit panel "Recommended for you" > to the "Catalogue search for the Learning Portal" field add the following "recommender?type=3". NOTE: 3 = content of type Course. Save.	Changes can be done.
6	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. The panel displays only courses.
7	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=43" > Save where 43 = content of type File.	Changes can be done.
8	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. On the "Recommended for you" panel there are only files available.
9	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=45" > Save where 45 = content of type WBT.	Changes can be done.
10	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. On the "Recommended for you" panel there are only WBT's available.

#	Step actions	Expected results
11	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=48" > Save where 48 = content of type Link.	Changes can be done.
12	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. On the "Recommended for you" panel there are only content of type Link available.
13	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=84" > Save where 84 = content of type Media file.	Changes can be done.
14	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. "Recommended for you" panel displays only content of type Media file.
15	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=3&bs=9" > Save where 3 = content of type Course and 9 = course booking state STARTED.	Changes can be done.
16	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. "Recommended for you" panel displays only courses that have similar title or description with the courses that the user has started.
17	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=3&bs=12" > Save where 3 = content of type Course and 12 = course booking state FAILED.	Changes can be done.
18	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. "Recommended for you" panel displays only courses that have similar title or description with the courses that the user has failed.
19	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=3&bs=6" > Save where 3 = content of type Course and 6 = course booking state WAITING.	Changes can be done.
20	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. "Recommended for you" panel displays only courses that have similar title or description with the courses that the user is on waiting state.
21	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=3&bs=7" > Save where 3 = content of type Course and 7 = course booking state CANCELLED.	Changes can be done.

#	Step actions	Expected results
22	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. "Recommended for you" panel displays only courses that have similar title or description with the courses that the user has cancelled.
23	Return to ILS and change the input of the field "Catalogue search for the Learning Portal" to "recommender?type=3&bs=11" > Save where 3 = content of type Course and 11 = course booking state PASSED.	Changes can be done.
24	Return to ILP and refresh the page. Take a look at the available content on the "Recommended for you" panel.	Refresh is done. "Recommended for you" panel displays only courses that have similar title or description with the courses that the user has passed.

How to use the popularity strategy:

#	Step actions	Expected results
1	Login to ILS with user imc_super and navigate to Dashboard administration > Panels Edit the "Recommended for you" panel and change: – for "Catalogue search for the Learning Portal" : recommender – for "Number of shown contents" select 10 – for "Display option for learning portal" select One tile per row Save and close.	Recommended panel was successfully saved.
2	Login in ILP with user recommend4. NOTE: user should NOT have any assigned or failed courses and NO Interests.	Login is possible. User does not have any assigned courses nor failed courses. User does not have any Interest defined on User Profile page.
3	Take a look at the content of the "Recommended for you" panel from Home.	The recommendations that are displayed on the panel are currently displayed based on the popularity strategy. Two courses are displayed: Recommender Test Course (Cat image) and Course forrecommender (The popularity is determined by the number of booked users for a course). And one media: File gif (the panel displays media that was added to the bookshelf by a number of users).
4	Go back to ILS , navigate to Dashboard administration > Panels. Edit the "Recommended for you" panel and change: – for "Catalogue search for the Learning Portal" : recommender?recf=bookedPersons^3&recf=bookshelfPersons^55 Save and close.	Changes can be done. First the media will be shown and then the courses because the weight value of the bookshelfPersons is higher then the value of the bookedPersons.

#	Step actions	Expected results
5	Navigate to Catalog assigment and trigger an "Update search index".	Update is done.
6	Return to ILP, trigger a refresh and take a look at the "Recommended for you" panel.	The panel displays first the media and then the courses, because weights were used to specify which information is more important to display first. Shown content are: media "File gif" and the two courses Recommender Test Course (Cat image) and Course forrecommender.
7	Go back to ILS, navigate to Content administration > Courses. Search for the Recommender Test Course (Cat image) and Course forrecommender courses. Open Participant administration and remove all users from the two courses > Save and close. Then navigate to Content administration > Bookshelf assignment > search for media "File gif' and remove all users > Save and close.	Changes can be done. Users were removed.
8	Navigate to Catalog assigment and trigger an "Update search index".	Update is done.
9	Return to ILP, trigger a refresh and take a look at the "Recommended for you" panel.	The panel displays random items (because user does not have any courses assigned, no interest, no popular items).

How to use the interest strategy:
Case 1: user has NO courses, NO failed courses but has Interests

#	Step actions	Expected results
1	Login to ILP with user "recommend5". NOTE: user should have NO courses assigned or failed courses.	Login is possible.
2	Login to ILS with user imc_super and navigate to Content setup > Classifications. Create a new folder > add title "Management" and description. On tab Settings mark all "Course and course type specific settings" and make shure that "Assignable object types" are Courses and Media > Save and Back. Select the Folder "Management" and create a new object inside the folder, add Title "Violet" > Save and back.	New Classification "Violet" was created.
3	Navigate to Content administration > Courses Search and edit course "Interest strategy course". Go to tab "Classifications" and add Classification "Violet". Save and close.	Classification is added to the course.

#	Step actions	Expected results
4	Navigate to Content administration > Media Search and edit media "Interest_link". Go to tab "Classifications" and add Classification "Violet". Save and publish.	Changes can be done.
5	Navigate to Customizing > Profiles and edit "Edit profile (Frontend)". On "Categories and attributes" tab, add attribute REC_INTERESTS. Save and close.	Attribute "Interest" can be added to the Edit profile (Frontend).
6	Navigate to Dashboard administration > Panels Edit the "Recommended for you" panel and change: – for "Catalogue search for the Learning Portal: recommender. Save and close.	Changes can be done.
7	Navigate to User > Manage Account and add as in Interests "Violet" > Save.	Profile can be updated.
8	Return to ILP and navigate HOME and check the content of the "Recommended for you" Panel.	The panel displays course "Interest strategy" and media "Interest_link" because these two have the same Classification as the user Interests.
9	Return to ILP and navigate HOME and check the content of the "Recommended for you" Panel.	The panel displays just media "Interest_link" because the media has the same Classification as the user Interests and the panel setting is to show only media of type link.
10	Return to ILS > navigate to Catalogue assignments and Update search index. Wait for the update to be done.	Search index can be updated.
11	Return to ILS and Navigate to Dashboard administration > Panels. Edit the "Recommended for you" panel and change: – for "Catalogue search for the Learning Portal" : recommender?type=48. Save and close.	Changes can be done.

Case 2: user has assigned courses, NO failed courses and has Interests

#	Step actions	Expected results
1	Follow the below Steps 2 - 5 if not done before.	Steps can be executed.
2	Login to ILS with user imc_super and navigate to Content setup > Classifications. Create a new folder (if not created already) > add title "Management" and description. On tab Settings mark all "Course and course type specific settings" and make sure that "Assignable object types" are Courses and Media > Save and Back Select the Folder "Management" and create a new object inside the folder, add Title "Violet" > Save and back.	New Classification "Violet" was created.
3	Navigate to Content administration > Courses. Search and edit course "Interest strategy course". Go to tab "Classifications" and add Classification "Violet" (if it was not added before). Save and close.	Classification is added to the course.
4	Navigate to Dashboard administration > Panels. Edit the "Recommended for you" panel and change: – for "Catalogue search for the Learning Portal" : recommender. Save and close.	Changes can be done.
5	Navigate to Customizing > Profiles and edit "Edit profile (Frontend)". On "Categories and attributes" tab, add attribute REC_INTERESTS. Save and close.	Attribute "Interest" can be added to the Edit profile (Frontend).
6	Login to ILP with user "recommend3". Navigate to Catalog > Recommender Catalog 2 and enroll user on course "Recommender Test Course" (Cat image). NOTE: user has NO failed courses and NO interests.	Login is possible. User is enrolled on course "Recommender Test Course" (Cat image). User has NO Interests. User has NO failed courses.
7	Return to ILS > navigate to Catalogue assignments and Update search index. Wait for the update to be done.	Search index can be updated.
8	Return to ILP and navigate HOME and check the content of the "Recommended for you" Panel.	The panel displays courses "Recommender Test Course" , "Interest strategy course" and media "Recommender Test Course" because these two courses and the medias TITLE or description are similar to the course that the user is booked to.
9	Navigate to user profile > Manage account and add as Interest "Violet" > Save.	Profile can be updated.
10	Navigate HOME and check the content of the "Recommended for you" Panel.	The panel displays only course "Interest strategy course" (because the course is similar to the one that the user is enrolled to and has the same Interest).