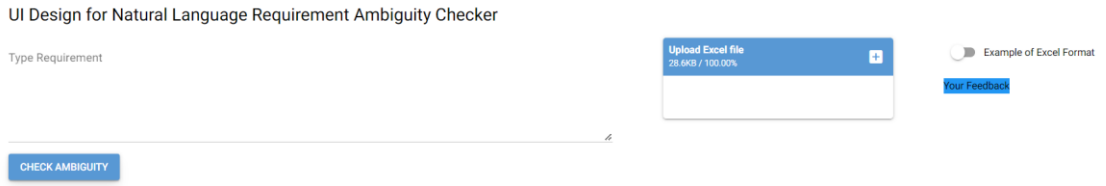
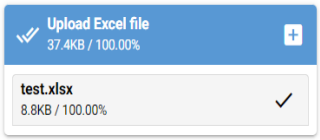
The prototype user interface is created by using NiceGui (https://nicegui.io/documentation#server_hosting), an open-source Python library for creating user graphical interfaces.

The title "*UI Design for Natural Language Requirement Ambiguity Checker* implies that the prototype is intended to be used to check ambiguities in requirements in natural language.

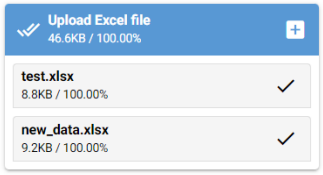


The user can type a text requirement, which might consist of one or more sentences. It should be in English, as the parser used in the text processing is specific for English. If the requirement written is in another language the tool will classify it probably as Ambiguous.

The user may also upload an Excel file using the Upload Excel File button (by clicking +). After the file has been uploaded, you will see a double tick on the left and the button displaying the file name and size. A prompt stating, Your file is uploaded will also appear.



Many files can be uploaded, but only one at a time can be checked for ambiguity. In the following example, the file *new_data.xlsx* is the last one uploaded and the one to be examined. By selecting the *single tick* ✓, you can remove a file, and by selecting the *double tick* ✓✓, you can erase all of the files.



The file must be in Excel format, with requirement in each row and optional comments.

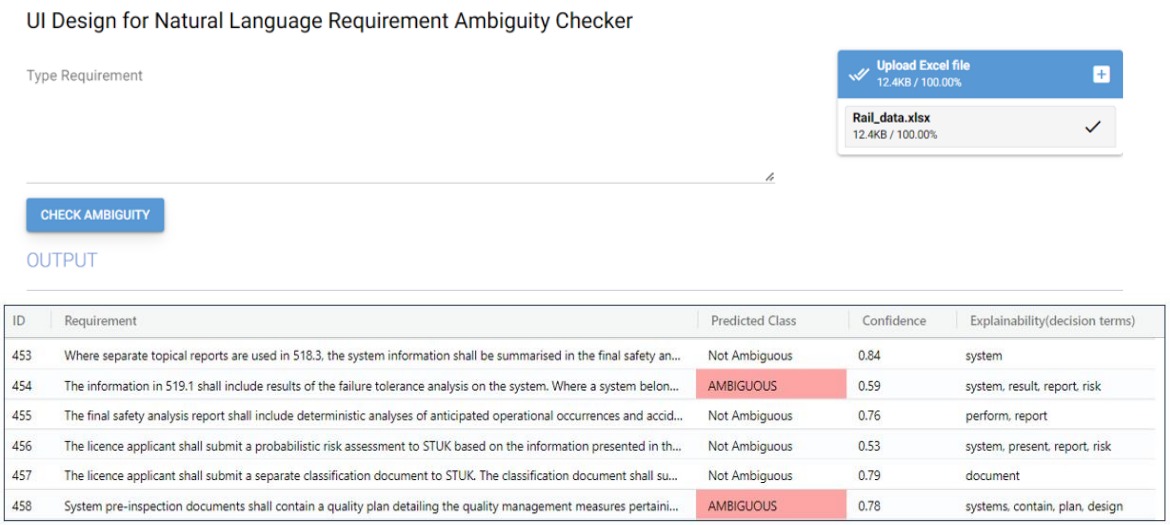
The excel file should not contain column names; if it does, it will be considered as a requirement (see first row). Ensure that the file's headers are removed.

OUTPUT

ID	Requirement	Predicted Class	Confidence	Explainability
1	Requirement	Not Ambiguous	0.91	Key decision terms:
2	It shall take no longer than the stated time to complete the following task: Pantograph (complete) - Exchange, 6...	Not Ambiguous	0.96	Key decision terms: take, longer, time

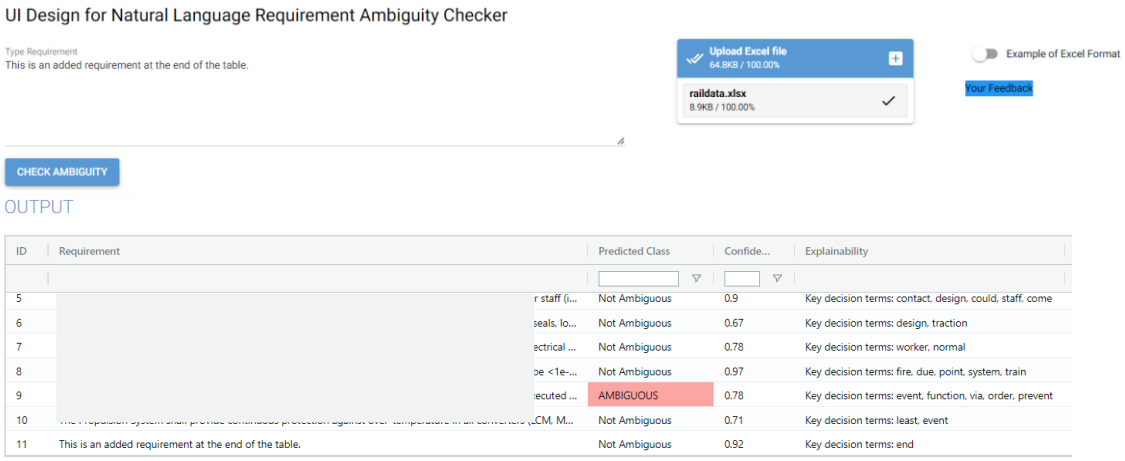
The Check Ambiguity button contains the logic of the classification. It invokes the trained models (SVM for classification and Decision Tree for term extraction) to categorize the requirements. After

pressing the button, the prediction is applied to the given data, and the outcomes are shown in the OUTPUT table. In the example below, some public accessible data [1] form given as *Rail_data.xlsx* was used by the model to present the classification below.



ID	Requirement	Predicted Class	Confidence	Explainability(decision terms)
453	Where separate topical reports are used in 518.3, the system information shall be summarised in the final safety an...	Not Ambiguous	0.84	system
454	The information in 519.1 shall include results of the failure tolerance analysis on the system. Where a system belon...	AMBIGUOUS	0.59	system, result, report, risk
455	The final safety analysis report shall include deterministic analyses of anticipated operational occurrences and accid...	Not Ambiguous	0.76	perform, report
456	The licence applicant shall submit a probabilistic risk assessment to STUK based on the information presented in th...	Not Ambiguous	0.53	system, present, report, risk
457	The licence applicant shall submit a separate classification document to STUK. The classification document shall su...	Not Ambiguous	0.79	document
458	System pre-inspection documents shall contain a quality plan detailing the quality management measures pertaini...	AMBIGUOUS	0.78	systems, contain, plan, design

The output will be unique for each file provided (if you want to mix numerous files, merge them in your computer and then upload one file). However, if you want to add a requirement in the text area, you can do so, and it will be added as the last row in the table. You can also write in all the requirements in the text area, which will be added and displayed in the tables (see below requirement with id 6 is added from text area).



ID	Requirement	Predicted Class	Confide...	Explainability
5	r staff (i...	Not Ambiguous	0.9	Key decision terms: contact, design, could, staff, come
6	seals, lo...	Not Ambiguous	0.67	Key decision terms: design, traction
7	ectrical ...	Not Ambiguous	0.78	Key decision terms: worker, normal
8	be <1e-...	Not Ambiguous	0.97	Key decision terms: fire, due, point, system, train
9	ecuted ...	AMBIGUOUS	0.78	Key decision terms: event, function, via, order, prevent
10	...CM, M...	Not Ambiguous	0.71	Key decision terms: least, event
11	This is an added requirement at the end of the table.	Not Ambiguous	0.92	Key decision terms: end

<u>The output will be:</u>

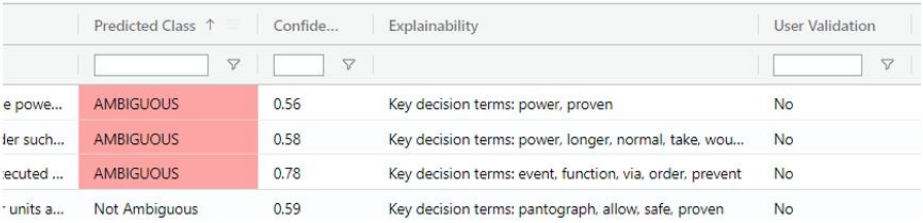
- ***ID***: unique for each requirement.
- ***Requirement***: contains requirements from uploaded file or typed in the text area-
- ***Predicted Class***: model's prediction as AMBIGUOUS or Not Ambiguous.
- ***Confidence***: confidence level of the classification.
- ***Explainability***: provides the terms that the model has use to classify each requirement in the class ambiguous or not. The terms for the AMBIGUOUS requirements contribute to the classification of the requirement as AMBIGUOUS.
- ***User Validation***: editable column, where the user can type the validation as *Yes* for *AMBIGUOUS* or *No* for *Not Ambiguous*. By default, all the values here are No, and they can

be changed. All ways are considered, so the model will recognize if the user writes Yes, YES, yes (No, NO, no).

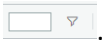
- ***Feedback***: The user can input sentence(s) to offer feedback on the classification, which will be utilized in a later version of the model that incorporates feedback. It would be helpful to add comments for ambiguous terms/sentences to assist the models become more distinct.

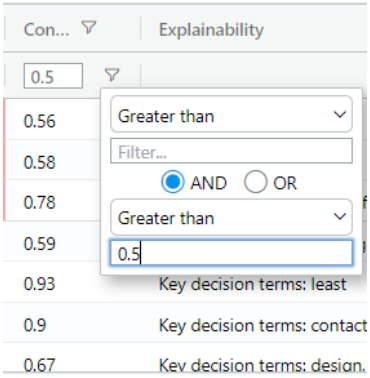
Filters

The column Predicted Class, Confidence and User Validation are equipped with filtering option. By clicking at the column name, you can automatically sort the column values (for example column Confidence can be ordered by id (by default), by clicking at Confidence name you can order in ascending and descending order), same for Predicted Class and User Validation.

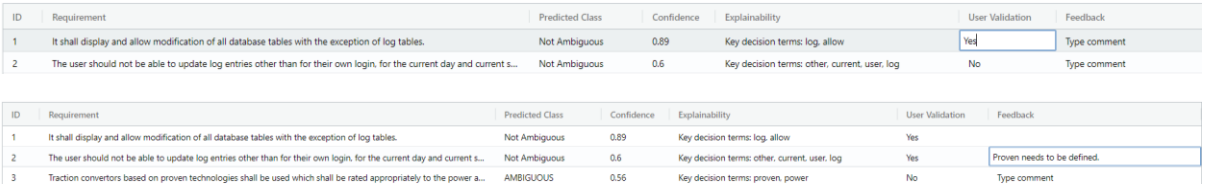


	Predicted Class	Confide...	Explainability	User Validation
e powe...	AMBIGUOUS	0.56	Key decision terms: power, proven	No
ler such...	AMBIGUOUS	0.58	Key decision terms: power, longer, normal, take, wou...	No
ecuted ...	AMBIGUOUS	0.78	Key decision terms: event, function, via, order, prevent	No
units a...	Not Ambiguous	0.59	Key decision terms: pantograph, allow, safe, proven	No

Furthermore, the columns have advanced filter options  . The column Confidence has filtered all the values greater than 0.5.



How to provide feedback

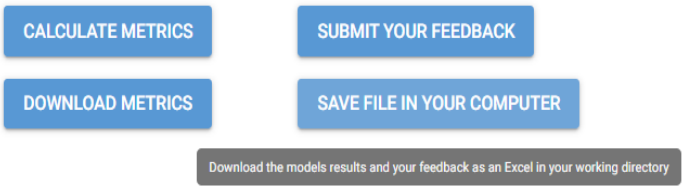


ID	Requirement	Predicted Class	Confidence	Explainability	User Validation	Feedback
1	It shall display and allow modification of all database tables with the exception of log tables.	Not Ambiguous	0.89	Key decision terms: log, allow	Yes	Type comment
2	The user should not be able to update log entries other than for their own login, for the current day and current s...	Not Ambiguous	0.6	Key decision terms: other, current, user, log	No	Type comment

ID	Requirement	Predicted Class	Confidence	Explainability	User Validation	Feedback
1	It shall display and allow modification of all database tables with the exception of log tables.	Not Ambiguous	0.89	Key decision terms: log, allow	Yes	
2	The user should not be able to update log entries other than for their own login, for the current day and current s...	Not Ambiguous	0.6	Key decision terms: other, current, user, log	Yes	Proven needs to be defined.
3	Traction convertors based on proven technologies shall be used which shall be rated appropriately to the power a...	AMBIGUOUS	0.56	Key decision terms: proven, power	No	Type comment

The user can click on each row to offer validation or feedback, and then save them by using the SUBMIT YOUR FEEDBACK button.

SUBMIT YOUR FEEDBACK will be updated and save all your inputs. Make sure to click it in case you make any changes.



CALCULATE METRICS – Once clicked, the button will compute the following metrics: True Positives (TP), True Negatives (TN), False Positives (FP), False Negatives (FN), Accuracy, Predicted Class Percentage (Ambiguous), Predicted Class Percentage (Not Ambiguous). The Predicted Class and User Validation will be used to compute True Positives, True Negatives, False Positives, False Negatives, and Accuracy. Only the Predicted Class will calculate the percentage of Ambiguous and the percentage of not Ambiguous requirements. Remember that these metrics are derived from the requirements you input and have nothing to do with how the model performed during training. They are also sensitive to the User Validation input.

TP provides the number of correct predictions among positive instances (Requirement is Ambiguous and is classified as so).

TN provides the number of correct predictions among negative instances (Requirement is Not Ambiguous and is classified as so).

FP provides the number of incorrect predictions (requirement is Not Ambiguous and is classified as Ambiguous).

FN provides the number of incorrect predictions (requirement is Ambiguous and is classified as Not Ambiguous).

Accuracy provides an estimation of how correct the model performed on the classification.

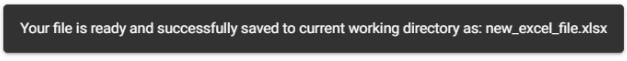
Predicted Class % (Ambiguous), Predicted Class % (Not Ambiguous) provide the % on how many the model classified as ambiguous and not ambiguous.

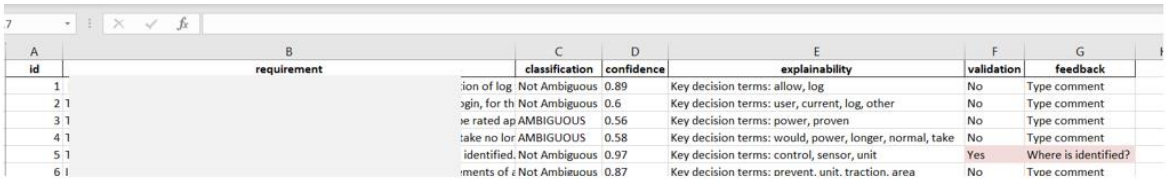
DOWNLOAD METRICS, the user can download the metrics locally on the computer. The default file *metrics.txt* will be created automatically in your working directory.

SAVE FILE IN YOUR COMPUTER will save the table with the results in your working directory.

ID	Requirement	Predicted Class	Confidence	Explainability	User Validation	Feedback
1		Not Ambiguous	0.89	Key decision terms: allow, log	No	Type comment
2	t day and current ...	Not Ambiguous	0.6	Key decision terms: user, current, log, other	No	Type comment
3	tely to the power ...	AMBIGUOUS	0.56	Key decision terms: power, proven	No	Type comment
4	lo so under such ...	AMBIGUOUS	0.58	Key decision terms: would, power, longer, normal, take	No	Type comment
5	The RLCS software shall initialize each control unit and device sensor as it is identified.	Not Ambiguous	0.97	Key decision terms: control, sensor, unit	Yes	Where is identified?

In the example below, feedback for requirement with id 5 is added as: "*Yes*" and "*Where is identified?*". Once saved clicked SAVE FILE IN YOUR COMPUTER the prompt below will show, and the table will be saved as an excel in your working directory.





id	requirement	classification	confidence	explainability	validation	feedback
1	ion of log	Not Ambiguous	0.89	Key decision terms: allow, log	No	Type comment
2	gin, for th	Not Ambiguous	0.6	Key decision terms: user, current, log, other	No	Type comment
3	e rated ap	AMBIGUOUS	0.56	Key decision terms: power, proven	No	Type comment
4	take no lor	AMBIGUOUS	0.58	Key decision terms: would, power, longer, normal, take	No	Type comment
5	identified.	Not Ambiguous	0.97	Key decision terms: control, sensor, unit	Yes	Where is identified?
6	ments of a	Not Ambiguous	0.87	Key decision terms: prevent, unit, traction, area	No	Type comment

If you attempt to click the button without submitting the changes: (User validation, Feedback) you will receive a prompt: Please click 'Submit Changes' first.

Ref: 1. Saad Ezzini, Sallam Abualhaija, Chetan Arora, and Mehrdad Sabetzadeh. Automated handling of anaphoric ambiguity in requirements: a multi-solution study. In Proceedings of the 44th International Conference on Software Engineering, pages 187–199, 2022.