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Abstract

This document describes the functionality and implementation of the online qualitative model repository for the collaborative version of the qualitative reasoning and modelling workbench Garp3. Qualitative models exported as Garp3 OWL files can be uploaded into the model repository. Users can search for qualitative models based on the model *content*, which is accessible due to the formalisation in OWL. The repository enables the qualitative modelling community to exchange qualitative models, provides access to earlier work to prevent redoing of work, and allows earlier work to be reused.

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1 Introduction

To allow storage, sharing and reuse of model fragments, qualitative models have to be made available to the Qualitative Reasoning (QR) community via an online model repository. One of the issues that had to be resolved was the file format for the exchange of qualitative models. The default format in which qualitative models are saved in the Garp3 qualitative modelling and simulation workbench [1] is binary. This format does not allow searching for qualitative models in which model ingredient definitions with specific names occur, or in which primitives are arranged in a certain manner.

The Semantic Web initiative proposes that this issue can be resolved by making content machine accessible [2]. We have followed this proposal by formalising the QR vocabulary, i.e. the ingredients and their usage restrictions, in the Web Ontology Language (OWL). Based on this formalisation, called a generic ontology [4], an OWL format for qualitative models was developed [3]. These model formalisations can be considered domain ontologies [4], and can be opened in different OWL editors. The formalisation of models in OWL has yielded some interesting research results for the OWL community [5]. In addition to the development of an OWL format for qualitative models, functionality was implemented in Garp3 to export qualitative models to the OWL format and to import them again [8]. In combination with the qualitative model repository, this allows for model sharing and model re-use.

This document is structured as follows. In chapter 2, the requirements and design are described. In chapter 3 the functionality and the implementation of the repository is discussed. Finally, chapter 4 concludes this document.

The development version of the qualitative model repository² is online, and will be integrated with the QRM Portal in due course³.

² <http://www.science.uva.nl/~jliem/Repository/>

³ <http://hcs.science.uva.nl/QRM/>

2 Requirements and Design

The qualitative model repository should focus on the content of the qualitative models. The reason for this is that there are few models that are annotated with meta-data, since the functionality to annotate qualitative models with meta-data has only been available since latest version of Garp3. Therefore, users should be able to look at the model ingredients that are defined in the models in the repository.

There are two different ways in which users should be able to search the model repository. Firstly, users should be able to browse through the models, when they are unsure what they are looking for. Secondly, users should be able to search for specific models using a search engine. Without guidance supporting users searching for models, it is likely that queries will yield no results. Therefore, users should see the content of the repository, and iteratively refine their search.

3 Functionality

3.1 Model Repository Index

The main page of the repository is used for model search (see Figure 1 and 2), and shows the model ingredients in all models in the repository ('All Ingredients'), the model ingredients in matching models ('Reduced Ingredients'), and the models that contain the selected model ingredients ('Valid Models'). The selected model ingredients are shown in red, while the model ingredients that do not match the query are shown in grey. These non-occurring model ingredients cannot be selected, as no models would match the query if the ingredient were added. Model ingredients can be removed from a query by deselecting them. Furthermore, the model ingredient types can be pressed to collapse the list of model ingredients of that type. This allows faster navigation of the model ingredient lists.

Selecting an unselected model ingredient from 'All Ingredients' or 'Reduced Ingredients' reduces the amount of matching models to the set that contains all the selected model ingredients. If multiple ingredients are selected, the repository searches for models in which both model ingredients occur. This allows users to iteratively refine their search for interesting models. Figure 1 shows the models which contain an entity 'Population', while Figure 2 shows a refined search for models which contain the entities 'Population', 'Carnivore' and 'Plant'. Note that entities are not the only model ingredients that can be searched for. All model ingredient definitions in the models can be used in a query.

Clicking on one of the matching models brings up further information about the model (see Figure 3). The model information is distilled from the OWL file and contains the title, author, contributors, keywords, model goals, target audience, model version, model limitations, language, bibliographic citation, abstract and remarks. Each model also has a rating and a number of downloads. This information is stored separately from the model in a relational database. If the user has not submitted a rating already, it is possible to submit a rating to indicate the quality of the model. Finally, there is a link that allows the model to be downloaded.

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Repository Index
Top Rated
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Qualitative Reasoning Model Repository

All Ingredients:	Reduced Ingredients:	Valid Models:
Entities: <ul style="list-style-type: none"> • A • Abiotic resource • Amphibians • Animal <ul style="list-style-type: none"> • Aquatic macrophyte • Bacteria • Biological entity • Bird • Birds • Carnivore • Collection • Container • Decomposer • Energy resource • Environment • Fish • Frog • General abiotic resource • Grass • Grass and palms • Habitat • Herbivore • Insect resource • Herbivore • Insects • Joint legs • Liquid • Living organism • Living organism collection • Macromvertebrate • Mineral resource • Object • Oil • Owl • Phytoplankton • Pipe • Plant • Population • Resource • River 	Entities: <ul style="list-style-type: none"> • A • Abiotic resource • Amphibians • Animal • Birds • Carnivore • Collection • Energy resource • Environment • Frog • General abiotic resource • Grass • Grass and palms • Habitat • Herbivore • Insects • Joint legs • Living organism • Living organism collection • Mineral resource • Owl • Plant • Population • Resource • Seed bank • Snake • Specific abiotic resource • Spinal cords • Water resource Agents: <ul style="list-style-type: none"> • Blup Assumptions: <ul style="list-style-type: none"> • Assume complex environment • Assume equality between needed and available 	<ul style="list-style-type: none"> • Single population-final.owl • population-vs2bita.owl • R-star-vs-10.owl

Figure 1: The model repository showing the models that contain the entity 'Population', and model ingredients in those models.

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Qualitative Reasoning Model Repository

All Ingredients:	Reduced Ingredients:	Valid Models:
Entities: <ul style="list-style-type: none"> • A • Abiotic resource • Amphibians • Animal <ul style="list-style-type: none"> • Aquatic macrophyte • Bacteria • Biological entity • Bird • Birds • Carnivore • Collection • Container • Decomposer • Energy resource • Environment • Fish • Frog • General abiotic resource • Grass • Grass and palms • Habitat • Herbivore • Insect resource • Herbivore • Insects • Joint legs • Liquid • Living organism • Living organism collection • Macromvertebrate • Mineral resource • Object • Oil • Owl • Phytoplankton • Pipe • Plant • Population • Resource • River • River delta • Snake • Seed bank 	Entities: <ul style="list-style-type: none"> • A • Animal • Carnivore • Environment • Herbivore • Plant • Population • Seed bank Agents: <ul style="list-style-type: none"> • Blup Assumptions: <ul style="list-style-type: none"> • Full correspondence available resource and production per capita • Full correspondence biomass to gross production • Not active • Seed bank exists • Simplifying assumption Configurations: <ul style="list-style-type: none"> • Consumes • Lives in Attributes: <ul style="list-style-type: none"> • Biomass • Consumption rate • Mort gross • Mort per capita • Net growth • Prod gross • Prod per capita • Resource available • Resource inflow • Seed bank • Waste rate 	<ul style="list-style-type: none"> • R-star-vs-10.owl

Figure 2: The model repository showing the models which contain 'Population', 'Plant', and 'Carnivore', and model ingredients in those models.

The screenshot shows the website interface for 'Qualitative Reasoning & Modelling'. At the top, there is a navigation menu with links: Home, Documentation, Software, Models, Community, FAQ, Glossary, Links, and About. A European Union flag is visible in the top right corner. Below the navigation, a sidebar on the left contains links: Repository Index, Top Rated, Top Downloads, and Upload Model. The main content area is titled 'Qualitative Reasoning Model Repository' and displays 'Model Information' for 'The R-Star Model'. The information includes: Author (Tim Nuttle), Contributors (Bert Bredeweg), Keywords (Plant resource system, uncertainty), Domain (Ecology), Model goals (Show how qualitative reasoning helps to deal with uncertainty), Target Audience (Ecologists), Model version (11), Model Limitations (None), Language (English), Bibliographic (Show how qualitative reasoning helps to deal with uncertainty), Citation (License:), and an Abstract. The abstract describes the model as a plant-resource system used to illustrate qualitative reasoning. Other details include a rating of five stars, zero downloads, and a download link: [RstarEcologicalModellingJune2006.owl](#). A note at the bottom states 'You have already rated this model.'

Figure 3: The repository showing specific information about a qualitative model, and the possibility to download it.

3.2 Top Ratings

The top rated link on the left side brings the user to a page which shows a list of models ordered by their rating (see Figure 4). The ratings are actually a real number between 0 and 5. Therefore the ordering of models with the same amount of stars reflects the more precise rating in the database. Models that have no rating are not shown in the list. Note that the ratings in Figure 4 are provided for demonstration purposes and do not reflect the actual quality of the models.

3.3 Top Downloads

The top downloads link brings the user to a page which shows a list of models ordered by the number of times they are downloaded (see Figure 5). The page also shows the data on which the model was first downloaded. Models that have not been downloaded are not shown in the list. Clicking on a model bring the user to a page showing more information about the model, and the possibility to download it (see Figure 5). Note that the number of downloads shown in Figure 5 have been manipulated to show the functionality, and do not reflect the actual popularity of the models.

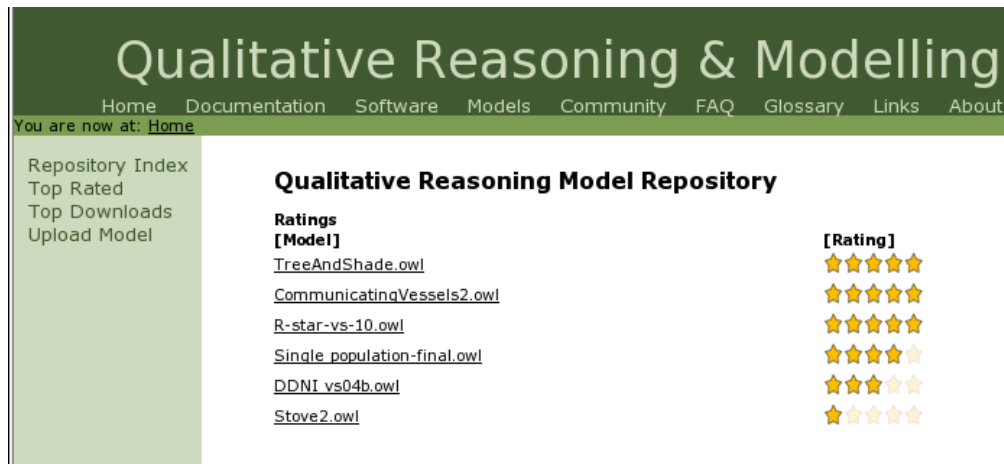


Figure 4: The 'Top Ratings' page showing a list of the models which are downloaded the most (fictional data).

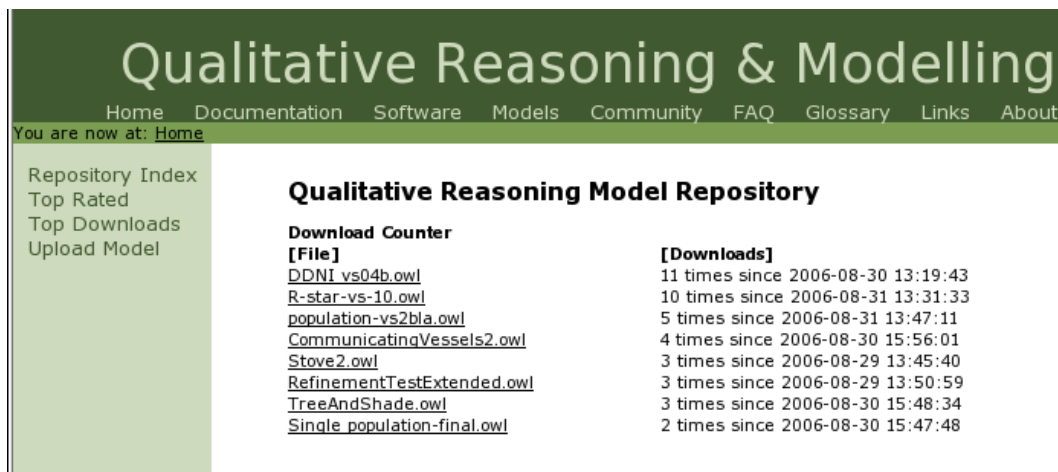


Figure 5: The 'Top Downloads' page showing a list of the models which are downloaded the most (fictional data).

3.4 Upload Model

The 'Upload Model' page allows users to upload their qualitative models (see Figure 15). Clicking the 'Browse...' button brings up a file manager in which the user can select a model file. Pressing 'Upload Model' uploads the model to the repository. The repository checks if the model is a valid XML file that ends with the .owl extension. If the model is not a valid .owl file, the repository indicates this and the user can try to upload a different model.

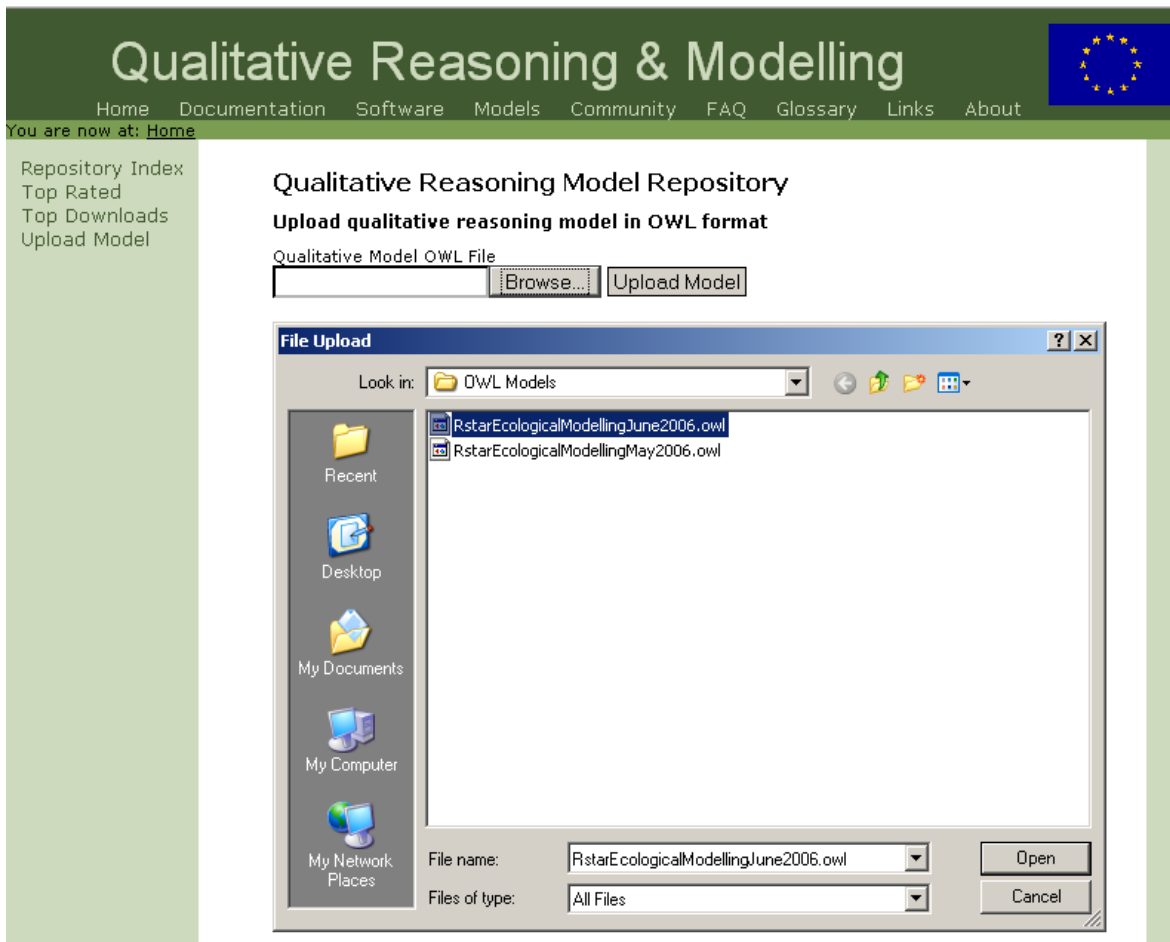


Figure 15: The upload page, and the file browser in which a file can be selected.

4 Implementation

4.1 Generating the Model Index

The repository index (see Figure 1 and 2) shows the model ingredients of the models in the repository. During development it became apparent that parsing a model file to retrieve the model ingredients takes anywhere from 0.08 to 0.52 seconds. If the number of models becomes larger, this could become a performance problem.

As an alternative solution a repository index generation program was developed. The program parses all the model files in the repository using the SWI-Prolog⁴ Semantic Web Library⁵. It generates an index of all the model ingredients and the models in which the model ingredients occur. This index is written to a PHP file which is loaded by the repository.

Since there is no SWI-Prolog running on the web server, it is not possible to regenerate the model index file after a file is uploaded immediately. Instead, the file is regenerated each hour as a cron job (a scheduled task).

4.2 Selecting Model Ingredients

Since the repository index consists of hundreds of model ingredients, using (X)HTML forms would create intricate and verbose markup. Instead, the page only contains one small form in which the currently selected model ingredients are specified as hidden form input fields. Each model ingredient on the page is a link which calls a javascript function. This function dynamically adds a new hidden input element to the form corresponding to the selected model ingredient, and then submits the form. The PHP code then generates lists of the model ingredients and the new form with selected model ingredients as hidden inputs.

4.3 Generating the Model Ingredient Lists

When a model ingredient is selected, all the selected model ingredients are posted to a PHP script that generates the model ingredient lists. It starts by reducing the amount of matching models based on the selected model ingredients. Afterwards, it reduces the amount of matching model ingredients based on the matching model ingredients.

4.3.1 Reducing the Matching Models

When a model ingredient is selected, all the selected model ingredients are posted to a PHP script. This script loads the model index PHP file which contains the model ingredients. This loads a data structure which associates each individual model ingredient to a set of models. For each selected model ingredient the associated set of models is gathered. The matching models are exactly the intersection of the sets of models associate to the selected model ingredients.

4.3.2 Reducing the Model Ingredients

Based on the matching models, the list of model ingredients is refined. This is done by looping though the model ingredients and removing the model ingredient if it is not

⁴ <http://www.swi-prolog.org/>

⁵ <http://www.swi-prolog.org/packages/semweb.html>

associated to at least one of the matching models. The resulting list contains only the model ingredients associated to one of the matching models. This is the 'Reduced Ingredients' list shown in Figure 1 and 2. The 'All Ingredients' list is generated by printing the original list, and adding links when the ingredient also occurs in 'Reduced Ingredients'.

4.4 Model Ratings

The model ratings are stored in a relational database. The ratings are stored as a row containing a model name, a rating and an IP address. The IP address prevents users from rating a model multiple times. The final rating for a model is calculated by grouping the rows by model name and averaging the ratings.

4.5 Model Downloads

The model downloads are counted by routing download requests through a PHP script. This script updates a relational database by incrementing the counter for the model (or creating an entry), and then sends the model file.

5 Conclusions

This document describes the online qualitative model repository, which enables the qualitative reasoning community to share models. This repository is meant to support collaboration within the community by preventing work to be redone, learning from previous work, and reuse of existing models and parts thereof.

Users can query the repository by iteratively selecting model ingredients which should be in the model. The lists of matching models and the model ingredients in those models are updated after each selection. Users can also look at the most downloaded or highest rated models.

Future work should add functionality to allow users to search on metadata. Since there are almost no models with metadata this functionality is not included yet.

6 References

1. B. Bredeweg, A. Bouwer, J. Jellema, D. Bertels, F. Linnebank, and J. Liem. Garp3 - A new Workbench for Qualitative Reasoning and Modelling. *20th International Workshop on Qualitative Reasoning (QR-06)*, C. Bailey-Kellogg and B. Kuipers (eds), pages 21-28, Hanover, New Hampshire, USA, 10-12 July 2006.
2. Grigoris Antoniou and Frank van Harmelen. *A Semantic Web Primer*, The MIT Press, Cambridge, Massachusetts, April 2004.
3. Liem, J., and Bredeweg, B., 2006. *Document Type Definition (DTD) for QR Model Fragments*, Naturnet-Redime, STREP project co-funded by the European Commission within the Sixth Framework Programme (2002-2006), Project no. 004074, Project Deliverable Report D2.3.1.
4. G. van Heijst, S. Falasconi, A. Abu-Hanna, G. Schreiber, and M. Stefanelli. A case study in ontology library construction. *Artificial Intelligence in Medicine* 7(3):227–255, June 1995.
5. J. Liem and B. Bredeweg. OWL and Qualitative Reasoning Models. In 29th annual German Conference on Artificial Intelligence (KI2006), 2006. *Lecture Notes on Artificial Intelligence*. Springer 2006. (To appear).
6. J. Wielemaker, G. Schreiber, and B. Wielinga. Using triples for implementation: the Triple20 ontology-manipulation tool. In Y. Gil, E. Motta, V. R. Benjamins, and M. A. Musen, editors, *International Semantic Web Conference*, pages 773–785, Berlin, Germany, November 2005. Springer Verlag. LNCS 3729.
7. Bredeweg, B., Bouwer, A., and Liem, J. (2006) *Requirements analysis and re-design for collaborative workbench*, Technical milestone report Naturnet-Redime, M4.2 (project number 004074), University of Amsterdam.
8. Liem, J., Bouwer, B., Bredeweg, B. (2006) *Collaborative QR model building and simulation workbench*, Naturnet-Redime, STREP project co-funded by the European Commission within the Sixth Framework Programme (2002-2006), Project no. 004074, Project Deliverable D4.3.