QsarDB – first 100 DOIs for predictive models

Uko Maran
Institute of chemistry, University of Tartu, Estonia

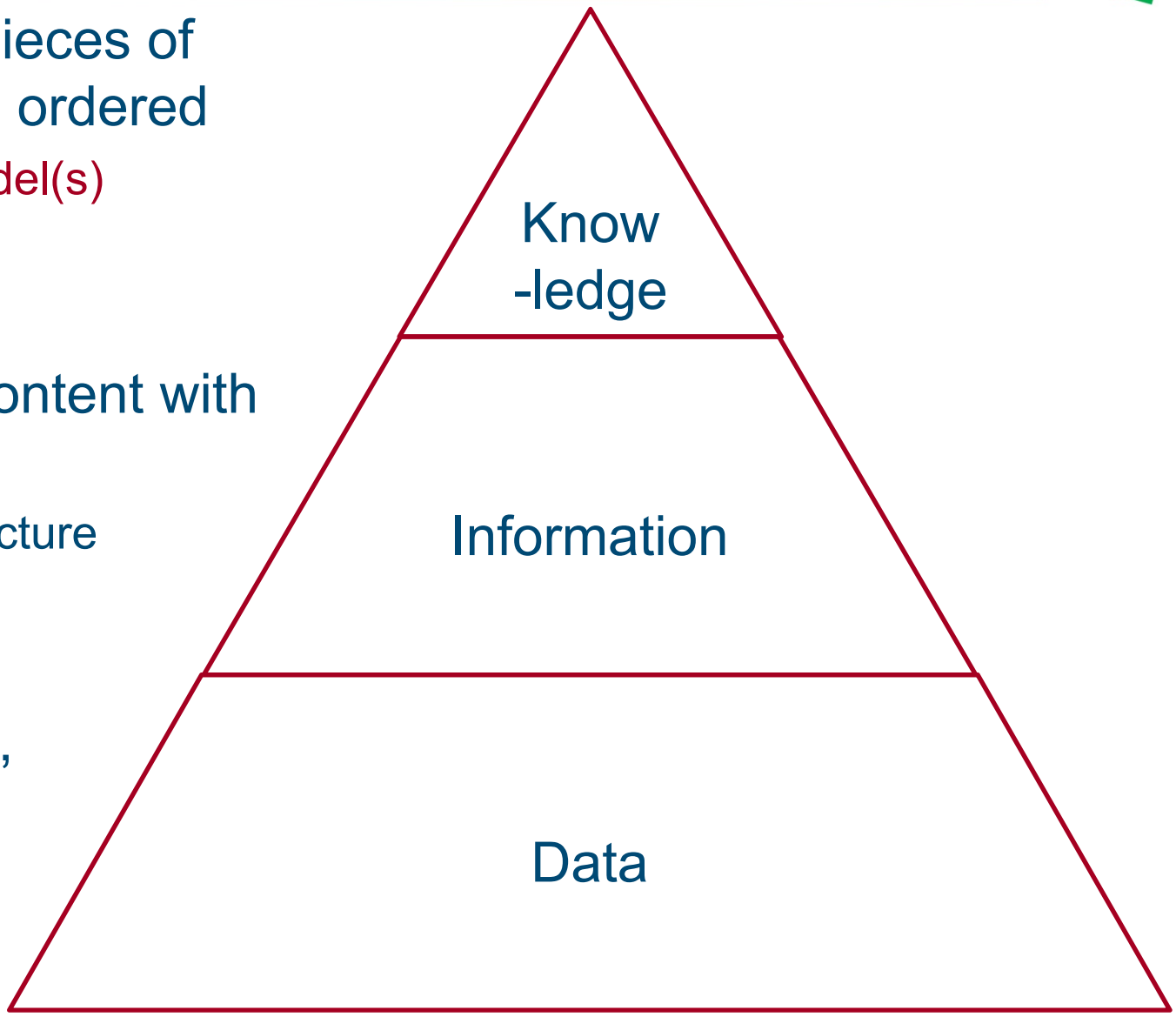
LOD: ★★★★★

Content

- Data
- Predictive (and descriptive) models?
- Goal
- Components
- Persistent digital identifiers
- First 100+ DOIs for predictive models

From data through information to knowledge

- Abstraction – pieces of information are ordered
  - In form of model(s)
- Data put into content with other data …
  - molecular structure
  - annotations
- Measurements, calculations



Gasteiger & Engel, Chemoinformatics, Whiley 2003

Predictive and descriptive models?

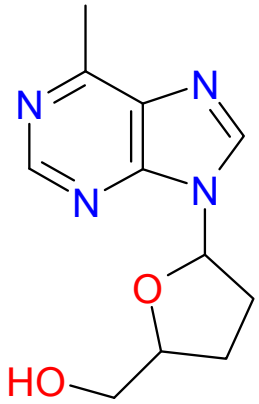
(Quantitative) Structure-Activity Relationships – (Q)SAR

Property

Physical
t_B , η, n_D, …
Chemical
pKa, *log*k, …
Specroscopic
δ_H,ν_{max}, …
Thermodynamic
ΔH_f, c_v, …
Biomedical
IC_{50}, LD_{50}, …

(Q)SAR/(Q)SPR methods:
Regression,
Arctificial neural networks,
Genetic algorithms,
Classification,
Etc.

Structure



Ψ=Ψ(r,R)

Activity = *f* (structure)

Main goal

QsarDB extends
the value of (published) predictive *in silico* models
in chemistry and
related areas of biomedicine, biotechnology,
predictive toxicology, etc.
via improving accessibility, transparency and reproducibility

What for QsarDB is designed?

- To preserve QSAR information
- To make QSAR information transparent
- To make QSAR information reproducible
- To make QSAR information accessible
- To make QSAR information easily transferable
- To adapt to the change in the structure of QSAR community … more model users than developers

Communication of *in silico* models

- Dominating approach … *printed media*

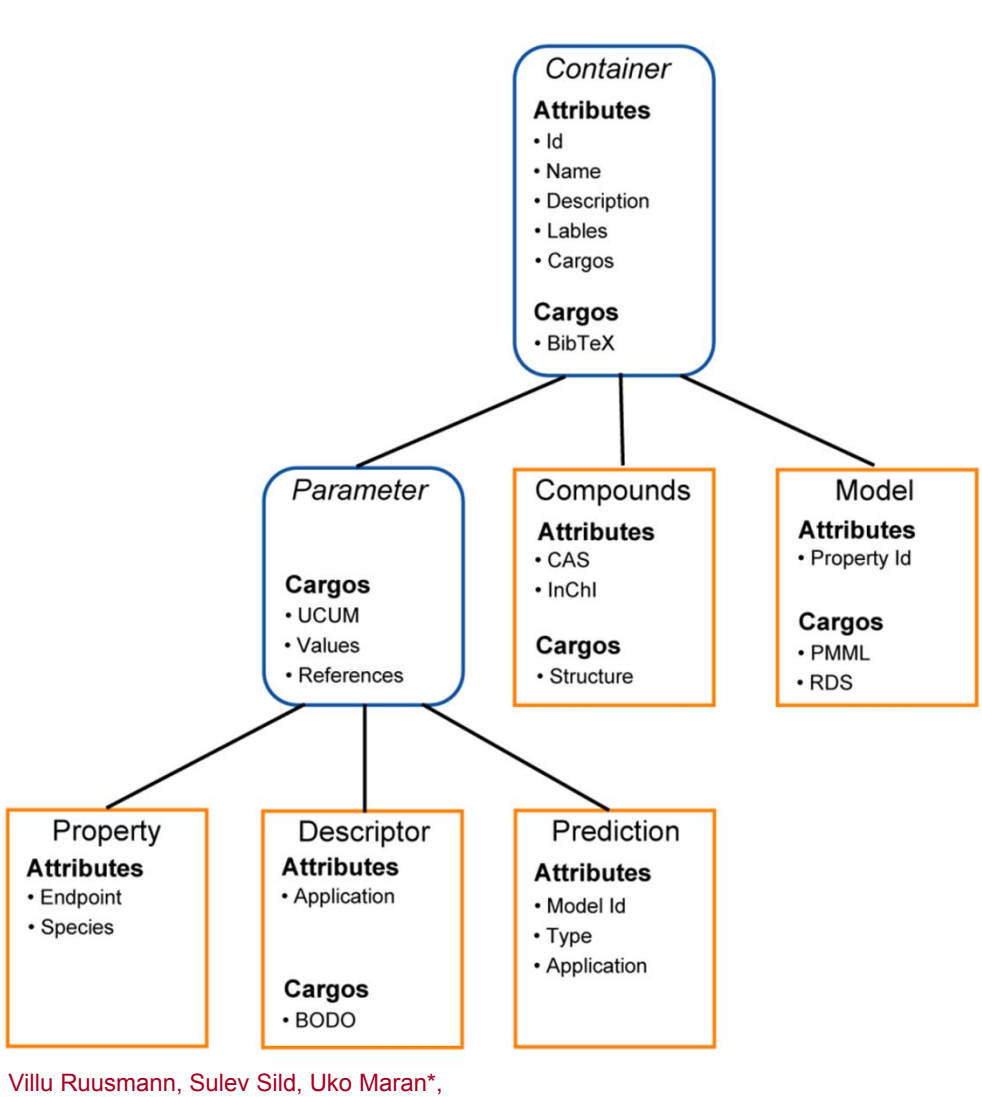
- The *main advantage* is
  - peer review process for the independent evaluation of the scientific work and
  - established distribution channels to reach the intended audience.

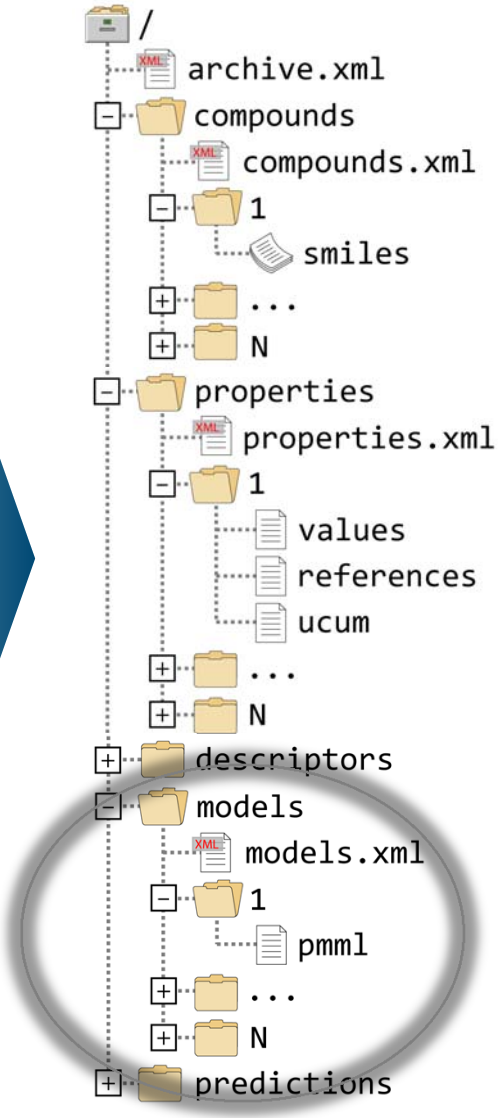
- The *disadvantage* is … static nature of printed media …
  - accessibility, traceability and reproducibility

QsarDB has three major components

- Data format
  - QSAR model archive (ie. small database - QDB)
- Smart Repository
  - collection of archives
- Tools for QDB archive creation
  - Command line
  - Graphical user interface

QsarDB data schema & format





Villu Ruusmann, Sulev Sild, Uko Maran*,
QSAR DataBank - an approach for the digital organization and archiving of QSAR model information.
Journal of Cheminformatics, 2014, 6:25. http://dx.doi.org/10.1186/1758-2946-6-25

Electronic representation of predictive models

- PMML
  - Open standard for representing data mining models in XML format
  - PMML covers the following topics
    - Data preprocessing described through data dictionary, mining schema, transformations
    - Model representation
    - Post-processing (e.g. scaling model outputs)
- Other options are possible:
  - For example RDS data format (R native model representation mechanism)

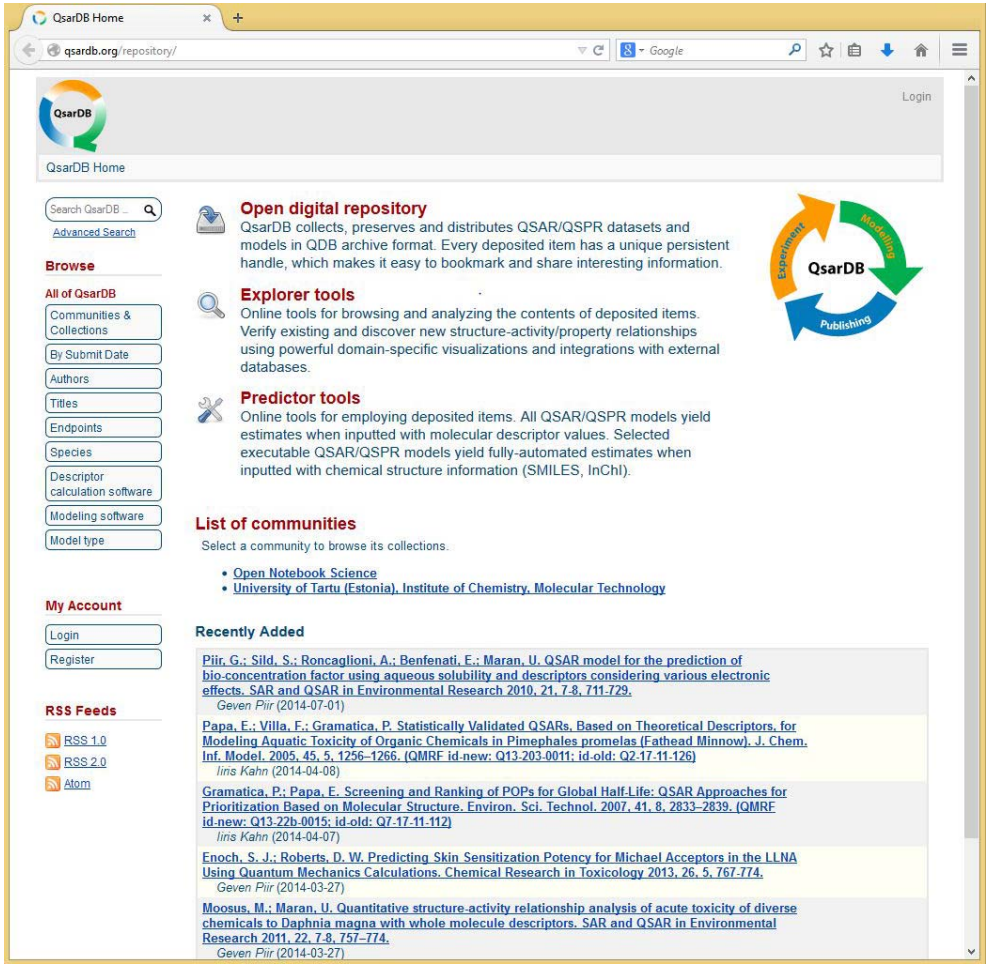
- PMML format supports:
  - Association rules
  - Cluster models
  - Neural network
  - Regression
  - Random forest
  - Tree models
  - Support-vector machines
  - Ensemble models (all of the above)

Smart repository: www.qsardb.org

- DSpace platform (`www.dspace.org`)
- Introduced QSAR specific metadata
- QsarDB archive submission process
- User interface of the web application
  - Item view to display information about QsarDB archive content
  - Explorer tool
  - Prediction tool
- Web service for predictions

Repository: Model uploading policy

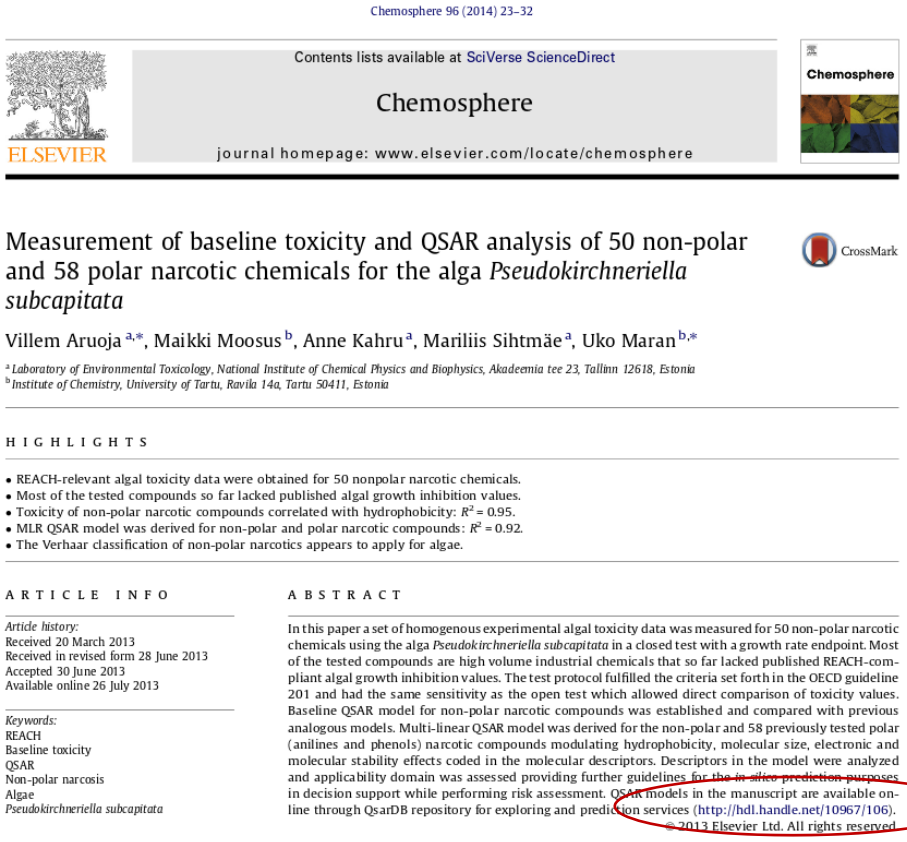
- Must have scientific publication
- (or have otherwise practical value …)



Repository: Persistent digital identifiers

- Handle service: http://hdl.handle.net/10967/106
- DOI support available starting from August 21-st

http://hdl.handle.net/10967/106 ⟶ http://qsardb.org/repository/handle/10967/106



Chemosphere 96 (2014) 23–32

Contents lists available at SciVerse ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Measurement of baseline toxicity and QSAR analysis of 50 non-polar and 58 polar narcotic chemicals for the alga *Pseudokirchneriella subcapitata*

Villem Aruoja [a,*], Maikki Moosus [b], Anne Kahru [a], Mariliis Sihtmäe [a], Uko Maran [b,*]

[a] Laboratory of Environmental Toxicology, National Institute of Chemical Physics and Biophysics, Akadeemia tee 23, Tallinn 12618, Estonia
[b] Institute of Chemistry, University of Tartu, Ravila 14a, Tartu 50411, Estonia

HIGHLIGHTS

- REACH-relevant algal toxicity data were obtained for 50 nonpolar narcotic chemicals.
- Most of the tested compounds so far lacked published algal growth inhibition values.
- Toxicity of non-polar narcotic compounds correlated with hydrophobicity: $R^2 = 0.95$.
- MLR QSAR model was derived for non-polar and polar narcotic compounds: $R^2 = 0.92$.
- The Verhaar classification of non-polar narcotics appears to apply for algae.

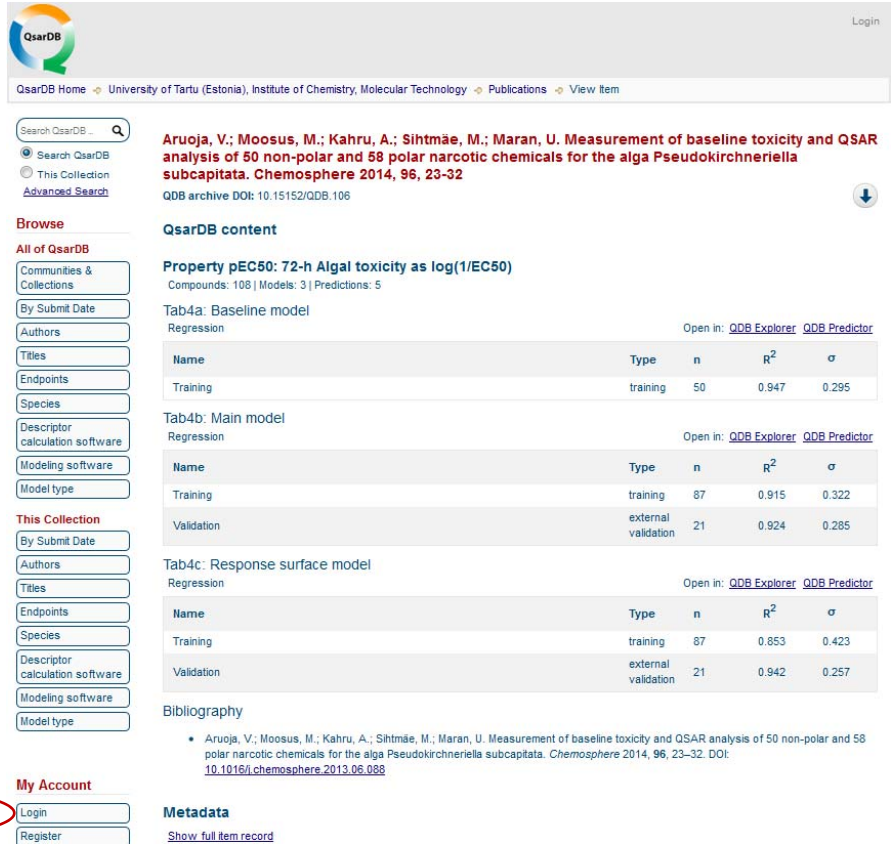
ARTICLE INFO

Article history:
Received 20 March 2013
Received in revised form 28 June 2013
Accepted 30 June 2013
Available online 26 July 2013

Keywords:
REACH
Baseline toxicity
QSAR
Non-polar narcosis
Algae
Pseudokirchneriella subcapitata

ABSTRACT

In this paper a set of homogenous experimental algal toxicity data was measured for 50 non-polar narcotic chemicals using the alga *Pseudokirchneriella subcapitata* in a closed test with a growth rate endpoint. Most of the tested compounds are high volume industrial chemicals that so far lacked published REACH-compliant algal growth inhibition values. The test protocol fulfilled the criteria set forth in the OECD guideline 201 and had the same sensitivity as the open test which allowed direct comparison of toxicity values. Baseline QSAR model for non-polar narcotic compounds was established and compared with previous analogous models. Multi-linear QSAR model was derived for the non-polar and 58 previously tested polar (anilines and phenols) narcotic compounds modulating hydrophobicity, molecular size, electronic and molecular stability effects coded in the molecular descriptors. Descriptors in the model were analyzed and applicability domain was assessed providing further guidelines for the *in silico* prediction purposes in decision support while performing risk assessment. QSAR models in the manuscript are available online through QsarDB repository for exploring and prediction services (http://hdl.handle.net/10967/106).



QsarDB

Login

QsarDB Home ⇨ University of Tartu (Estonia), Institute of Chemistry, Molecular Technology ⇨ Publications ⇨ View Item

Search QsarDB ...

Search QsarDB
This Collection
Advanced Search

Browse
All of QsarDB
Communities & Collections
By Submit Date
Authors
Titles
Endpoints
Species
Descriptor calculation software
Modeling software
Model type

This Collection
By Submit Date
Authors
Titles
Endpoints
Species
Descriptor calculation software
Modeling software
Model type

My Account
Login
Register

Aruoja, V.; Moosus, M.; Kahru, A.; Sihtmäe, M.; Maran, U. Measurement of baseline toxicity and QSAR analysis of 50 non-polar and 58 polar narcotic chemicals for the alga Pseudokirchneriella subcapitata. Chemosphere 2014, 96, 23-32

QDB archive DOI: 10.15152/QDB.106

QsarDB content

Property pEC50: 72-h Algal toxicity as log(1/EC50)

Compounds: 108 | Models: 3 | Predictions: 5

Tab4a: Baseline model

Regression — Open in: QDB Explorer QDB Predictor

Name	Type	n	R^2	σ
Training	training	50	0.947	0.295

Tab4b: Main model

Regression — Open in: QDB Explorer QDB Predictor

Name	Type	n	R^2	σ
Training	training	87	0.915	0.322
Validation	external validation	21	0.924	0.285

Tab4c: Response surface model

Regression — Open in: QDB Explorer QDB Predictor

Name	Type	n	R^2	σ
Training	training	87	0.853	0.423
Validation	external validation	21	0.942	0.257

Bibliography

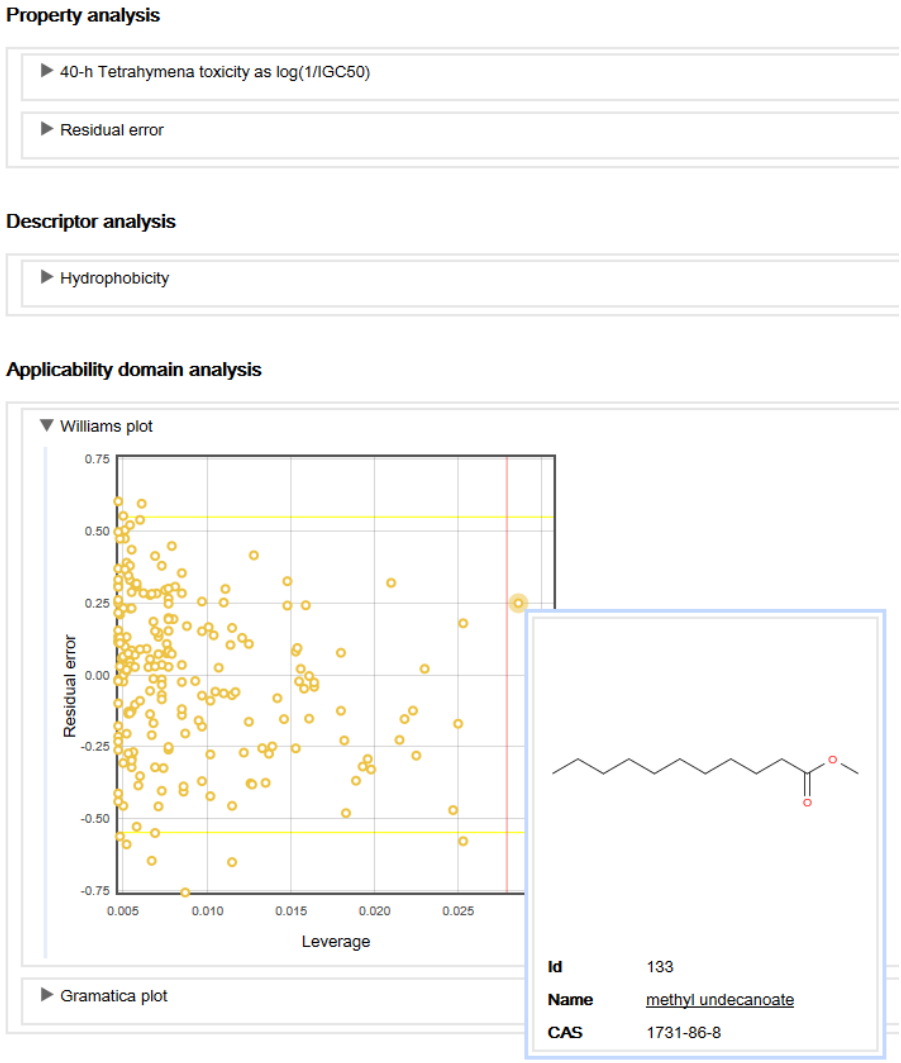
- Aruoja, V.; Moosus, M.; Kahru, A.; Sihtmäe, M.; Maran, U. Measurement of baseline toxicity and QSAR analysis of 50 non-polar and 58 polar narcotic chemicals for the alga Pseudokirchneriella subcapitata. *Chemosphere* 2014, **96**, 23–32. DOI: 10.1016/j.chemosphere.2013.06.088

Metadata

Show full item record

Repository: Explorer – visualization

- Visualizes
  - property data;
  - residuals;
  - descriptors;
  - applicability domain;



Repository: Predictor

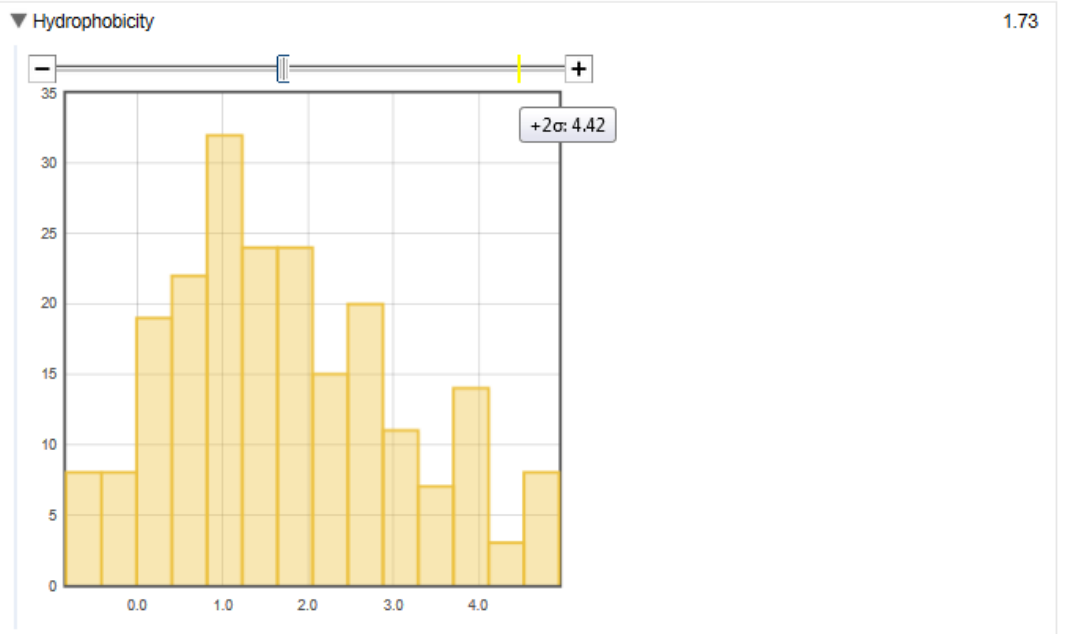
- Predict:
  - from structure
  - from descriptors
    (safe for commercial users)

Model input

Chemical structure input (InChI or SMILES format):

Calculate

Descriptor input:



Model output

40-h Tetrahymena toxicity as log(1/IGC50)	=	0.723 * Hydrophobicity - 1.79
	=	0.723 * 1.73 - 1.79
	=	**-0.5392**

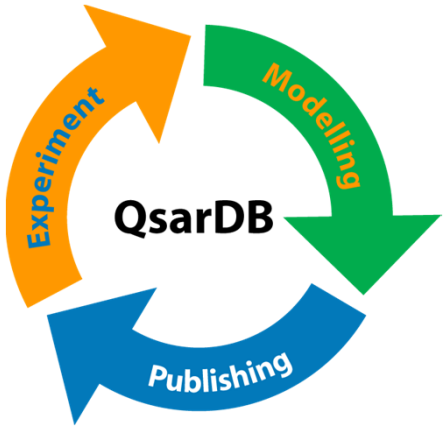
First 100+ DOIs for predictive models

- http://dx.doi.org/10.15152/QDB.106
- 108 DOI-s (as of 23.10.2014)
- 244 descriptive & predictive models (23.10.2014)
- QsarDB qualifies in all five Linked Open Data concept criteria:
  - OL … Open License (★)
  - +RE … machine REadable (★★)
  - +OF … Open Format (★★★)
  - +URI … Uniform Resource Identificator (★★★★)
  - +LD … Linked Data (★★★★★)

Concluding Phrases

- One of our aims and reason for QsarDB is to
  - help modelers to keep their published (static PDF) models alive … (for example http://dx.doi.org/10.1016/j.chemosphere.2013.06.088)
- Making Smart Repository even smarter:
  - structure & similarity search, etc.
  - new model types are coming in …
  - access for the scientific communities …
  - …
- Preparing for interactive scientific publications!

Thank you!



Investing in your future

European Union
Regional Development Fund

www.qsardb.org

(project # 3.2.1201.13-0021)