German Environment Agency

National and Kapodistrian UNIVERSITY OF ATHENS

Umwelt Bundesamt

TerraChem Pro

Leveraging Transfer Learning for Predicting Chemical Half-Lives in Mammals to Screen for Bioaccumulation in Air-Breathers

Reza Aalizadeh*[1], Dominik T. Nerlich*[2,5], Peter C. von der Ohe[2], Nikolaos S. Thomaidis[1], Guy Duke[3], Jaroslav Slobodnik[3], Peter Fantke[4,5], Henner Hollert[5,6], Gabriele Treu[2,5]

[1]Laboratory of Analytical Chemistry, National and Kapodistrian University of Athens, Athens, Greece | [2]German Environment Agency (UBA), Dessau-Roßlau, Germany | [3]Environmental Insitute, Kos, Slovakia | [4]substitute ApS, USEtox Team, Copenhagen, Denmark | [5]Department Evolutionary Ecology & Environmental Toxicology (E³T), Goethe University Frankfurt, Frankfurt am Main, Germany | [6]Department Environmental Media Related Ecotoxicology, Fraunhofer Institute for Molecular Biology and Applied Ecology IME, Schmallenberg, Germany

Introduction

Elimination half-lives $^{elim}t_{1/2}$ have been proposed as being more accurate than traditional log K_{OA}/K_{OW} based approaches to screen for bioaccumulation of chemicals in air-breathers[1]. Still, the amount and accessibility of experimental data on $^{elim}t_{1/2}$ is limited. Thus, **deep learning models,** like TerraChemPro, are promising non-animal **alternatives** to overcome these **data gaps** in future.

Objectives

Creating and validating a **novel screening tool** to identify chemicals as potentially (very) **bioaccumulative (vB/B) in mammals** to decide on regulatory follow-up assessment:

→ robust screening criteria for big data
→ as line of evidence for vB/B assessment
→ open-access +easy to use for regulators

Ongoing works

Software update (v3.0)

→ curation of toxicokinetic data (species/administration type/route)
→ implementation of a batch mode
→ comparisons with *in vitro* studies
→ predicts $^{elim}t_{1/2}$ dose depended (single vs. repeated doses)

Methodology

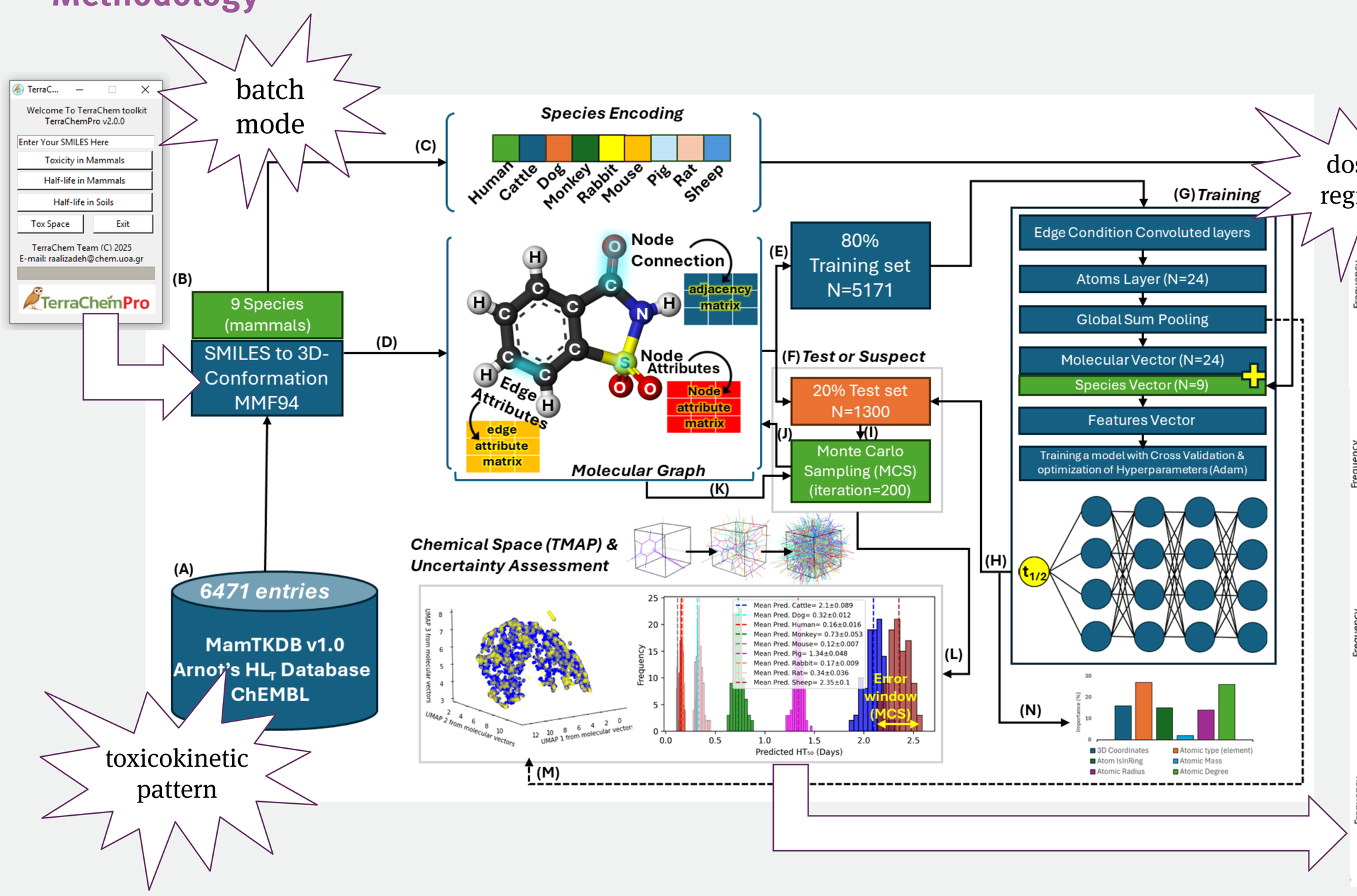

Figure 1: Software features: (A) collection of $^{elim}t_{1/2}$[2-4]; (B) generation of 3D confo rmers from SMILES; (C) encoding of species data; (D) specification of chemical properties; (E) training and (F) test set; (G) layers of the training procedure; (H) model evaluation; (I) iteration steps; (K) regenerated graph data; (L) estimate standard deviation; (M) UMAP/TMAP- based visualization of learned chemical space; (N) feature importance towards $^{elim}t_{1/2}$.

Outlook -- Open-access software release 2026

→ implementation via NORMAN consensus modeling[5]
→ applicable as prioritization tool for regulators & companies to reach sustainability

Literature

[1] https://fcld.ly/airbreathingmammalsl [2] https://doi.org/10.1016/j.envint.2021.106592 [3] https://doi.org/10.1021/acs.jcim.3c02030 [4] https://pubs.acs.org/doi/10.1021/es4029414 [5] https://norman-network.com/nds/prioritisation/

Co-funded by the European Union

Project funded by
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

*Contacts:

Reza Aalizadeh
raalizadeh@chem.uoa.gr

Dominik Nerlich
dominik.nerlich@uba.de