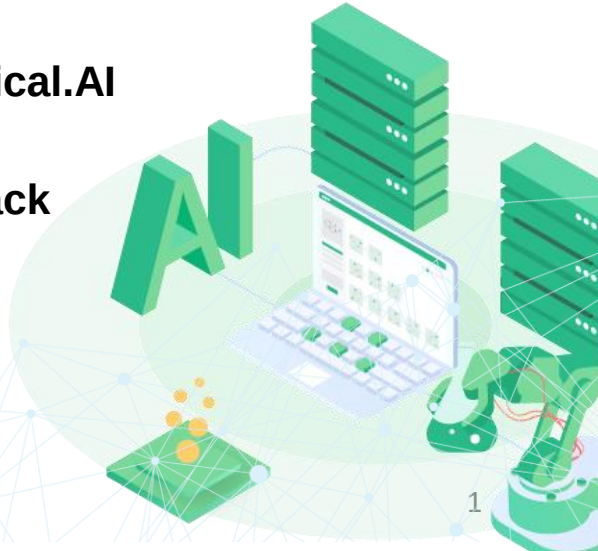
Chemical.AI

Plan Your Synthetic Routes with ChemAIRS™

Drive the innovation of drug research

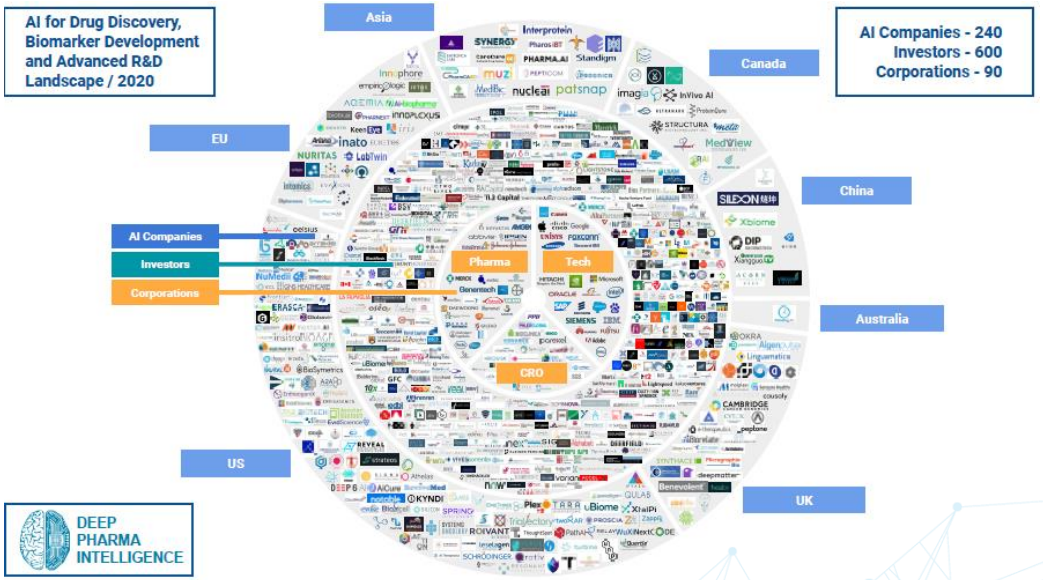
Content



AI in drug discovery and drug development

Pharmaceutical organization	AI organization	Collaborative work
Roche	OWKIN	Drug discovery and development, clinical trials based on ML networks
Pfizer	XtalPi	Use of quantum mechanics and ML algorithms with cloud computing architecture to predict the 3D structure of molecules, depicting their mechanical and chemical properties, and how they bind with protein receptors
Pfizer, NOVARTIS	IBM Watson	Use of ML, natural language processing, and cognitive reasoning technologies in immuno-oncology to find new drug targets, combination therapies, and patient selection strategy ies
		Improved health outcomes for patients with breast cancer
NOVARTIS	Microsoft	Research on cell and gene-based therapies, generative chemistry, image segmentation and analysis for smart and personalized delivery of therapies, and optimization of cell and gene therapies at scale
MATEON THERAPEUTICS	PointR DATA	Treatment of late-stage melanoma, gliomas, and pancreatic cancer
BAYER	Sensyne Health	Clinical development of new treatments for cardiovascular disease using Sensyne Health's proprietary clinical AI technology platform.
BAYER, SANOFI	Exscientia	Exscientia uses its Centaur Chemist™ AI drug discovery platform to optimize novel lead structures for potential drug candidates for treatment of cardiovascular and oncological diseases
		To discover and develop bispecific small molecules for diabetes and its comorbidities
Boehringer Ingelheim	healx	Healnet, an AI-based platform, is used to find therapies for rare neurological diseases
Takeda, SERVIER	Numerate	To find drug molecules for oncology, gastroenterology, and central nervous system disorders
		Design of small-molecule modulators of ryanodine receptor 2 (RyR2), a target identified in cardiovascular diseases using proprietary algorithm-driven drug discovery platform
Eli Lilly and Company	Atomwise	Develop drugs on novel protein targets
janssen, AstraZeneca	BenevolentAI	BenevolentAI assumes exclusive right to develop, manufacture, and commercialize Janssen's novel clinical-stage drug candidates; already used to provide clinical data in Phase IIb trials of bavisant in patients with Parkinson's disease and excessive daytime sleepiness
		Neural network-based platforms for discovery and development of new treatments for chronic kidney disease and idiopathic pulmonary fibrosis

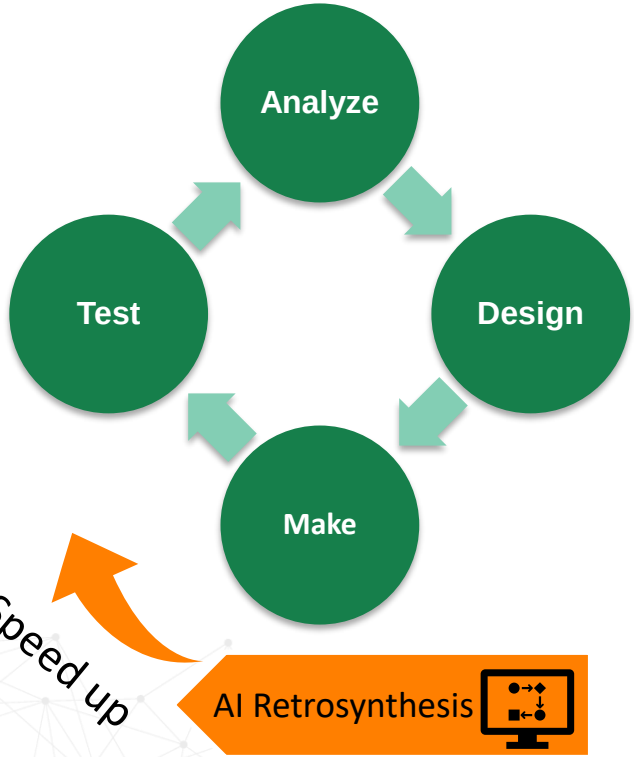
Drug Discovery Today



Drug Disco. Today **2020**, 10.1016/j.drudis.2020.10.010

Deep Pharma Intelligence, *Artificial Intelligence in Pharma* ***2020***

Solution: Computer-aided Synthesis Planning



The application of machine learning to synthetic problems has also generated considerable interest and excitement. One area of active research is the use of algorithms for synthetic route planning to a target molecule.

Campos *et al., Science* **2019**, *363*, 244

The impact of machine learning-based predictive chemistry is already being observed at some companies, and adoption by chemists is on the rise.

K. F. Jensen *et al., J. Med. Chem.* **2020**, *63*, 8667

Establishing an AI retrosynthesis tool that will increase speed of synthesis with shortest and most reliable routes, which ultimately speeds up the design cycle.

History and evolution of Chemical.AI

We have been working on predictive retrosynthesis system (ChemAIRS™) for years!

2008

Started to work on cheminformatics

2012

Demo version of retrosynthesis based on data

2015

Data extraction and cleaning

2016

Retrosynthesis website on-line

2017-2018

Improvement of algorithm

2019-

Product maturation and commercialization

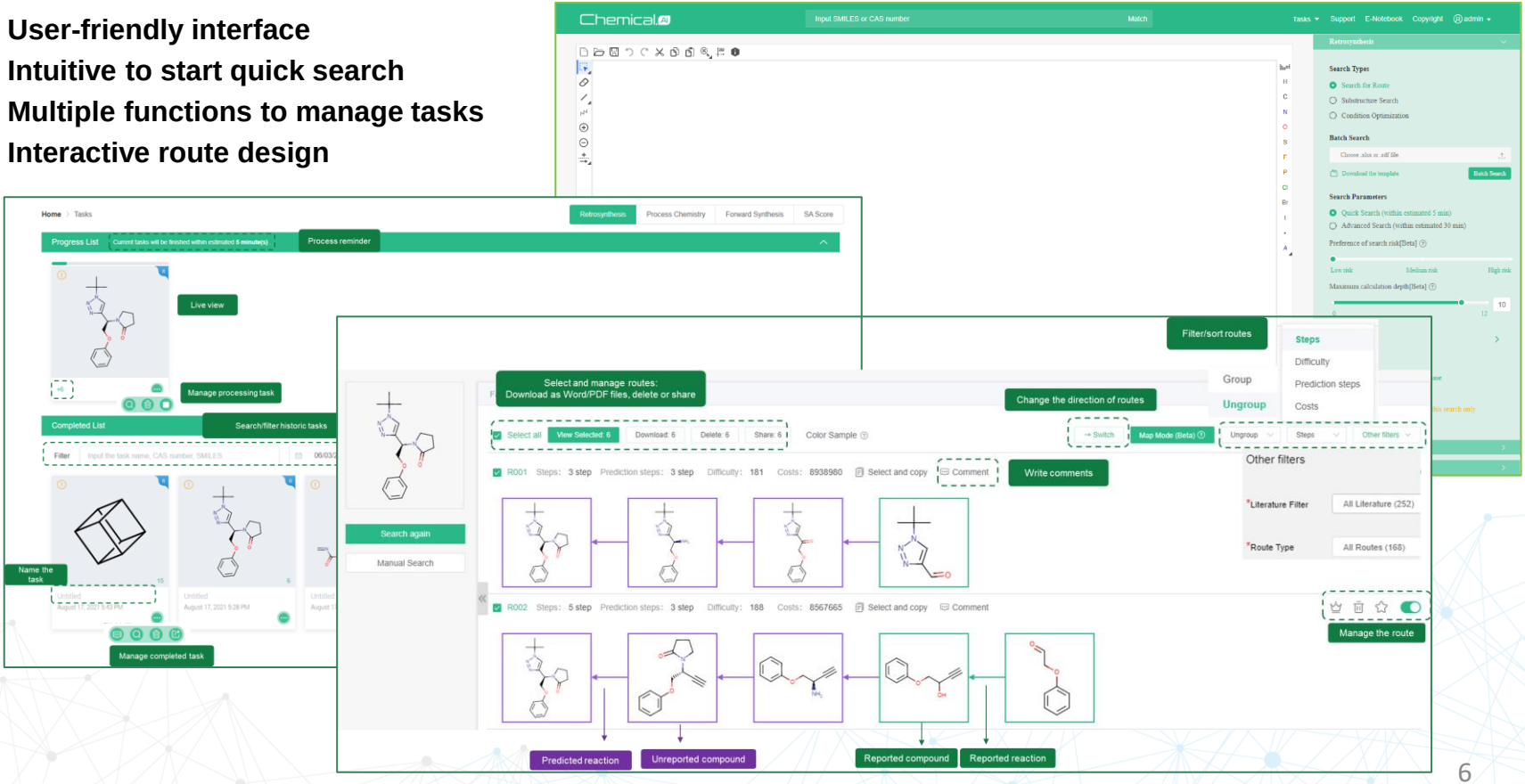
ChemAIRS™ combines expertise and machine learning

Chemical.AI developed its own algorithm independently. The key is to break complex synthetic problems into small and simple ones with chemistry meaning, then use data and machine learning to solve them.

Advantages	Development
1. Learn form data automatically 2. Expert knowledge to adjust the algorithms 3. Integrate internal data 4. Explainable and easy to debug and improve	1. Feed more data 2. Continue to improve algorithms 3. Develop more products and solutions for different scenarios

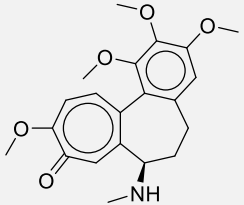
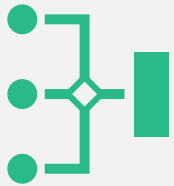
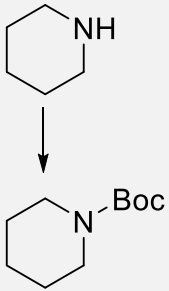
Easy to start retrosynthesis

- User-friendly interface
- Intuitive to start quick search
- Multiple functions to manage tasks
- Interactive route design

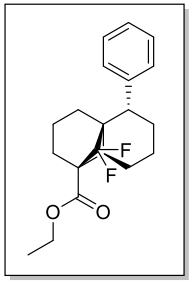


We are at leading position in AI retrosynthesis

Key features of retrosynthesis at ChemAIRS™

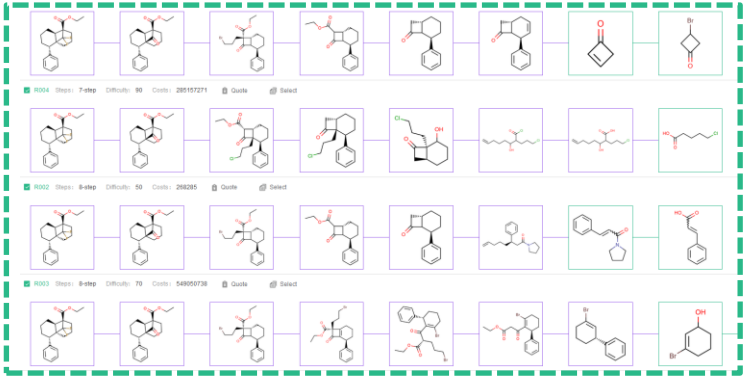
Fast search speed	Feasibility	Protection group strategy	Stereochemistry	Diversity
				
20 routes in 80s	Reference: Similarity			Multiple strategies
Quick Search from seconds to 5 min	*Reactions prediction based on relevant references*	*Compatibility check and implementation of protective group strategy*	*Identification of chirality center and make the right transformation*	*Diversity of routes to quickly provide different ideas as a start*

Predict diverse routes for novel and complex molecules



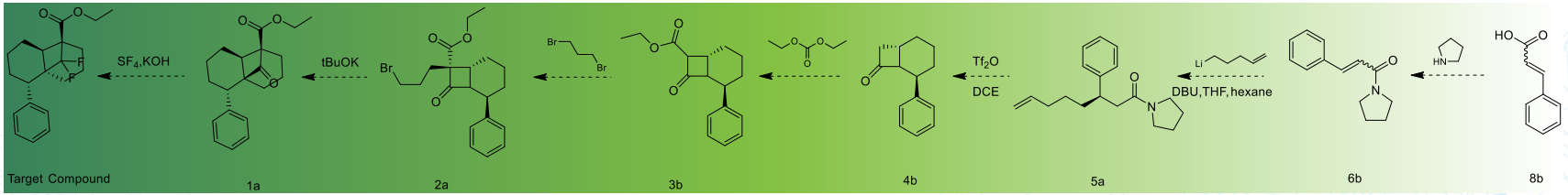
- Unknown molecule
- Multiple chirality centers
- Polycyclic system
- 4-member ring

ChemAIRS™



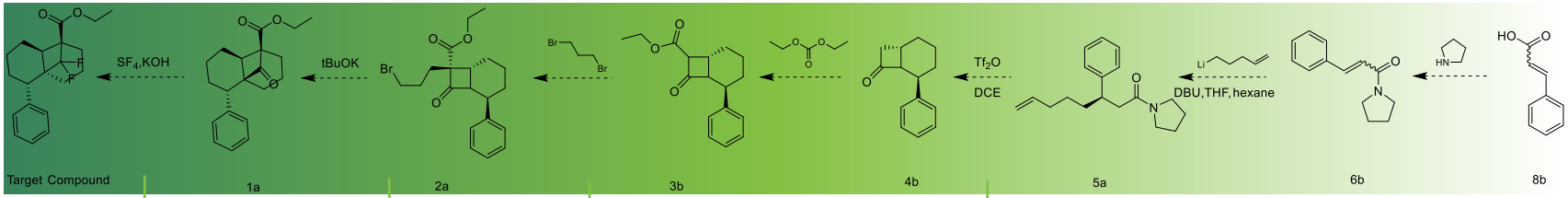
Diverse synthetic planning

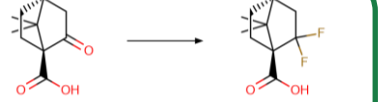
One possible route



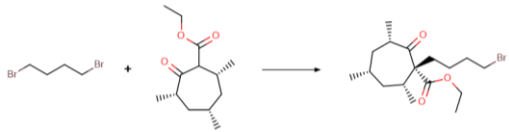
Solid ideas: Feasibility of predicted routes

Predicted reactions with supported and high related references

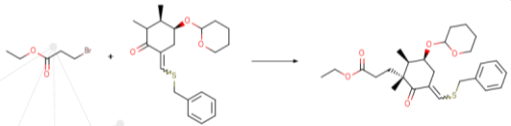




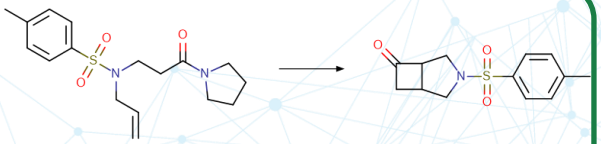
J. Fluorine Chem. **2000**, 104, 273



J. Org. Chem. **1973**, 38, 1061



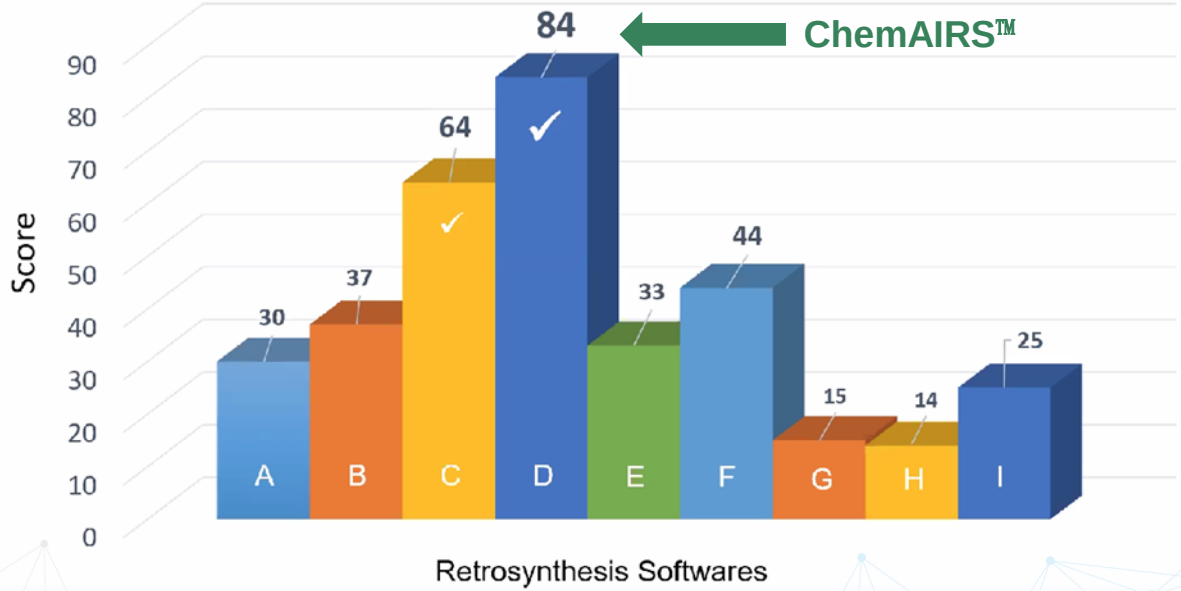
Tetrahedron **1988**, 4339



WO2015/38661; A1

Comparison test with other products

Evaluation of route generating softwares with 60 diverse targets



Glorius, F. *et al, Chem. Soc. Rev.*, **2020,** 1039. (Introduction + Perspective)

American Chemical Society C&EN: Quantum Mechanics & Artificial Intelligence in Med Chem Syntheses
https://event.on24.com/wcc/r/2535189/50DCCB31E7392F8CF9BC9A374B4EE925

Positive feedback from users

1. User-friendly interface, easy to start search;
2. Predict multiple routes for most molecules;
3. Provide diverse routes to open the mind;
4. Functions to filter/sort routes;
5. Export routes to PDF/CDX files for group sharing;
6. Responsive to users' feedback.

Leading global pharmaceutical companies and CROs collaborate with us

More solutions to accelerate R&D

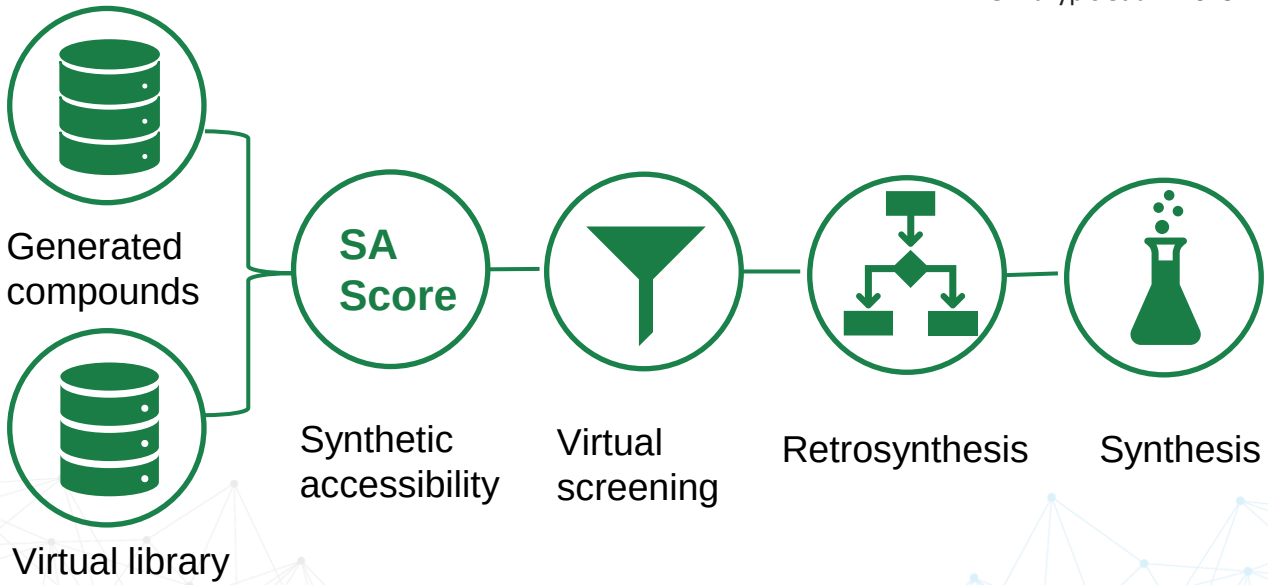
Integration our technologies into your research workflows

1. Synthetic Accessibility evaluation (SA Score) to pre-screen molecule library
2. Integration of in-house data: building blocks and reactions data from ELNs, etc.
3. Customized professional solutions, including API development
4. Forward synthesis to generate virtual library
5. Routes generation for process chemistry

SA Score: Scientific background

- With *de novo* rational drug design, scientists can rapidly generate a very large number of potentially biologically active probes. However, many of them may be synthetically infeasible and, therefore, of limited value to drug developers.

G. Karypis *et al. J. Chem. Inf. Model.* **2010,** *50,* 979–991

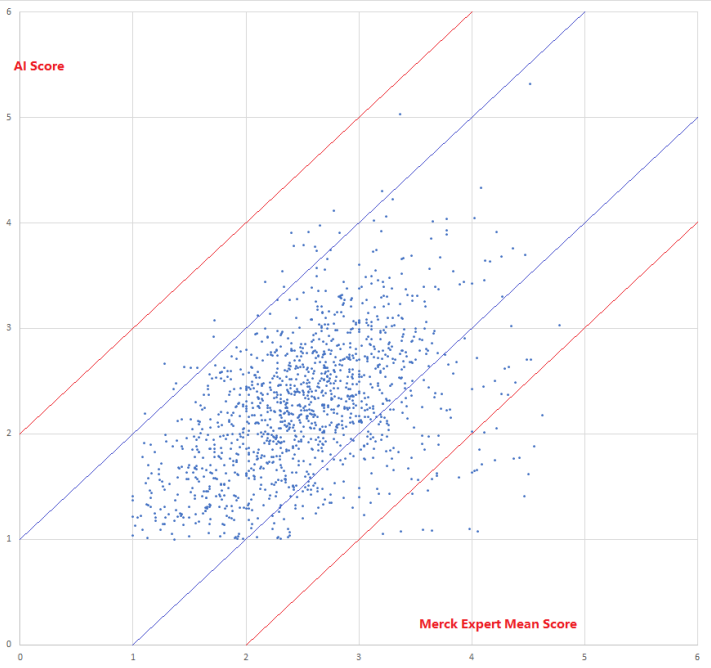


SA Score:
Quick evaluation of molecule synthetic accessibility

Experimental synthesis of selected compounds

Modified from J-L. Reymond *et al.* chemrxiv.13019993.v1

SA Score: Results analysis and comparison



SA Score comparison between Merck meanComplexity and *Chemical. AI* for 1346 molecules

- Difference between Chemical.AI and Merck meanComplexity:
  86% of all molecules: within **1** (within blue lines)
  98% of all molecules: within **2** (within red lines)
- In general, SA score of Chemical.AI is **lower** than Merck meanComplexity, as AI knows better the development of the diversity of molecular synthesis methods and the availability of commercial building blocks.

In addition, SA Score module from Chemical.AI provides *SimiSAScore* and *DiffiScore* considering the similarity and difficulty of reactions

THANK YOU!

Contact: support@chemical.ai