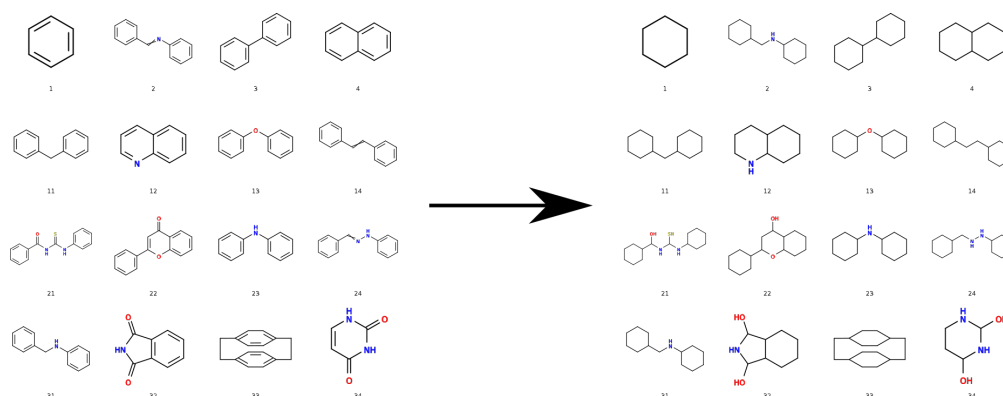


1 Background

The Bemis-Murcko scaffold¹ provided by DataWarrior² retains information about bond order and chirality. There are instances where retaining only information about which atoms are connected with each other, but not their bond order is desired. This corresponds to the assumption 'there are only single bonds'. DataWarrior equally offers the export of Bemis-Murcko skeleton, however this simplifies e.g. the scaffold about an imidazole into one of cyclopentane.



2 Typical use

The script is to be used on the CLI of Python3 with the mandatory parameter about listing file containing the SMILES to work with:

```
python saturate_MurckoScaffolds.py [listing_file.txt]
```

to generate `saturated_Murcko_scaffold.csv` as permanent record. The script equally works with the legacy of Python2.17, too.

3 Example

For a collection of organic materials, the Bemis-Murcko scaffolds was extracted with DataWarrior (release 5.0.0 for Linux) as listing `Murcko_scaffolds_with_bond_order.txt`. The "saturation" was obtained by

```
python saturate_MurckoScaffolds.py Murcko_scaffolds_with_bond_order.txt
```

yielding `saturated_Murcko_scaffold.csv`. For a visual survey about the scaffolds, `openbabel`³ allows a quick check on the CLI by writing a `.svg`, here as:

¹Bemis GW, Murcko MA *J. Med. Chem.* 1996, **39**, 2887-2893, doi 10.1021/jm9602928

²Sander T, Freyss J, von Korff M, Rufener C, *J. Chem. Inf. Model.* 2015, **55**, 460-473, doi 10.1021/ci500588j. The program, (c) 2002–2019 by Idorsia Pharmaceuticals Ltd., is freely available under <http://www.openmolecules.org>.

³www.openbabel.org. This outline is based on release 2.4.1 (Nov 12, 2018) provided by Linux Xubuntu 18.04.2 LTS.

```
1 obabel -ismi Murcko_scaffolds_with_bond_order.txt -O  
  ↪ Murcko_scaffolds_with_bond_order.svg -xc10 -xr12 -xl --addinindex
```

This formats the output as an array of 10 columns (-xc10) by 12 rows (-xr12) with a grid (-xl), where the entries are labeled in order of their appearance in the input file (--addinindex). If using the GUI of openbabel instead of the CLI, the later optional parameter is called Append input index to title.⁴

The .svg may be post-processed further to yield a .pdf or a .png, for example cairosvg⁵ by a call of

```
1 cairopdf Murcko_scaffold_with_bond_order.svg -o Murcko_scaffold_with_bond_order.pdf
```

Alternatively, the .svg may be processed in programs like inkscape.⁶

As desired, this "artificial saturation" of double / triple / aromatic bonds retains the information about which atoms are directly connected with each other. openbabel's algorithm to display the molecular structures deals surprisingly well even with sometimes complicated motifs (e.g., the scaffold of cyclophane [entry #33], sparteine [#38], or adamantane [#50]).

⁴By default, openbabel attributes element specific colors. Especially if the output is print black-and-white, the labels about atoms like hydrogen, silicon, sulfur, phosphor, then might be barely intelligible, especially at low scale. It is possible to toggle off the colors by adding -xu as additional parameter of openbabel's conversion after the definition of the output file.

⁵<https://cairosvg.org/>

⁶<https://inkscape.org>