Aromatics Analyser CSD-Materials

CCDC Virtual Workshop 2020 – Session 3

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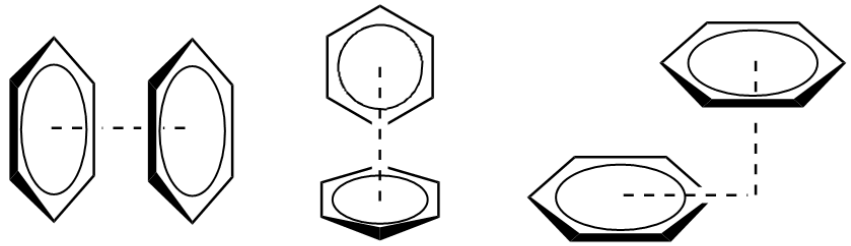
advancing structural science

Learning outcomes for today

- Why use Aromatics Analyser?

  Van der Waals < Aromatic Interactions < Hydrogen Bonds

- Familiarise yourself with the Aromatics Analyser interface.
- Learn how to distinguish favourable Aromatic Interactions in a structure.
- Learn about different orientation of Aromatic Interactions in a crystal structure



Read more about Van der Waals, Aromatic and Hydrogen Bond Interactions in the *Dictionary* on the handout.

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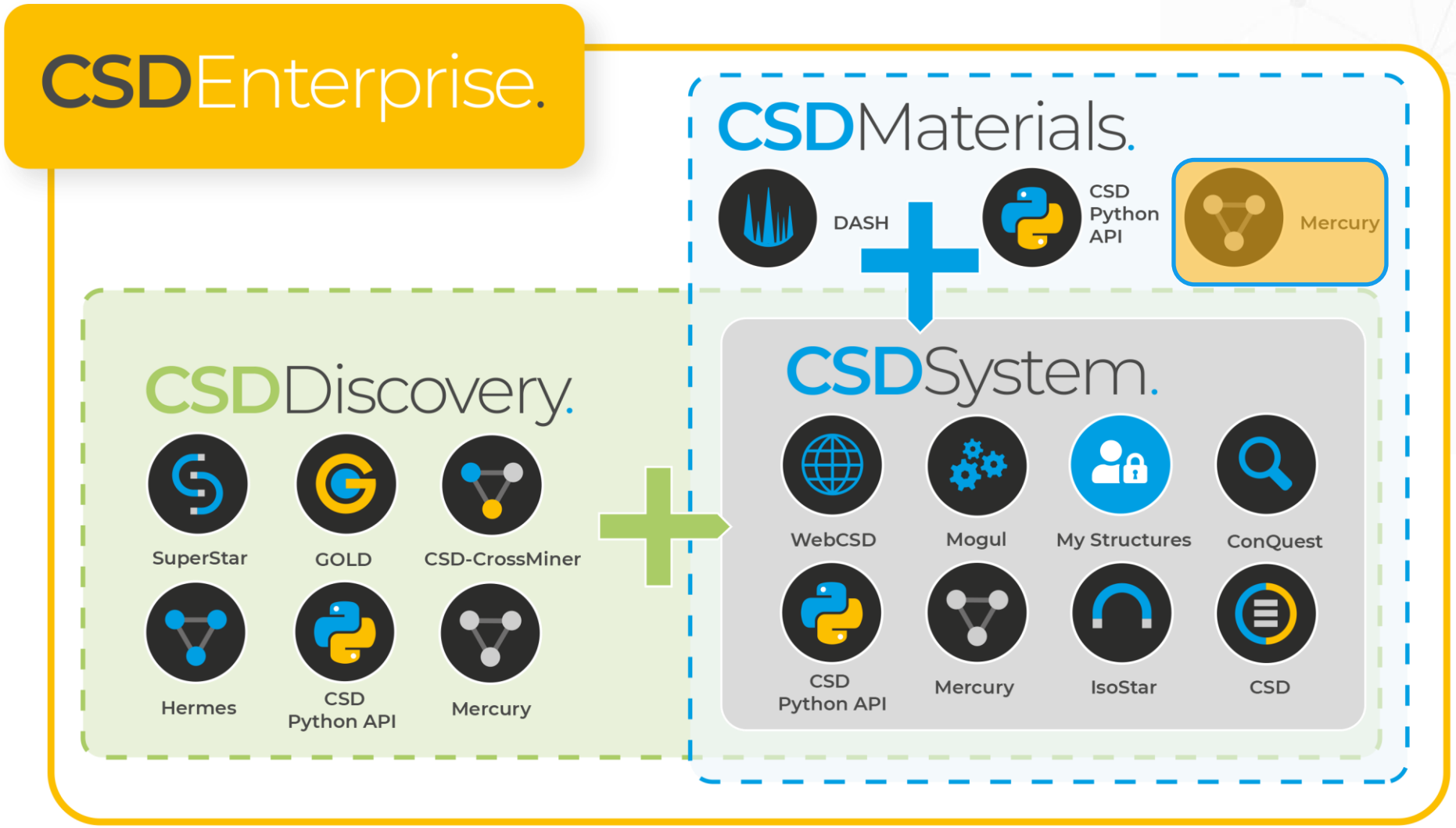
The CSD software



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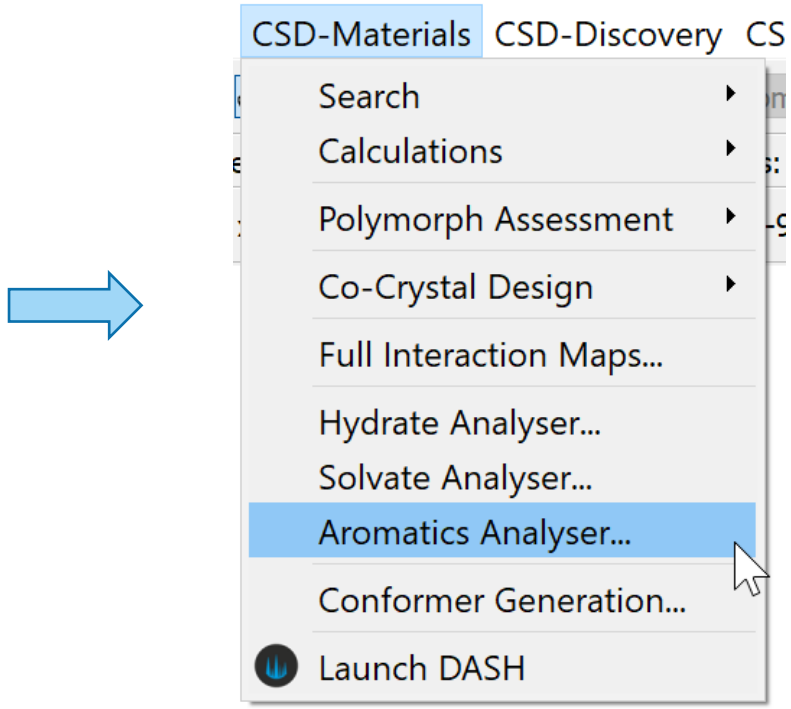
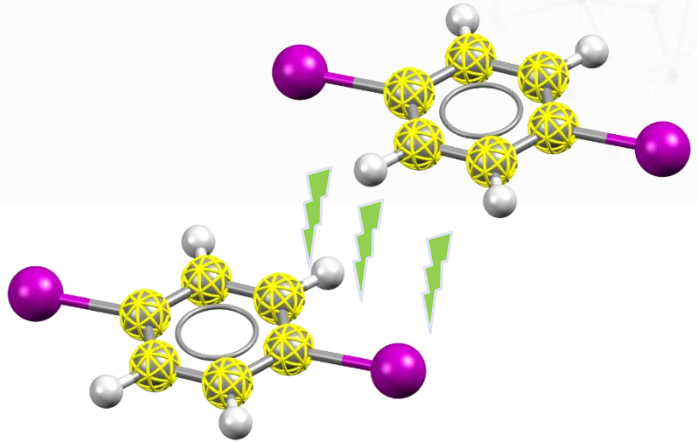
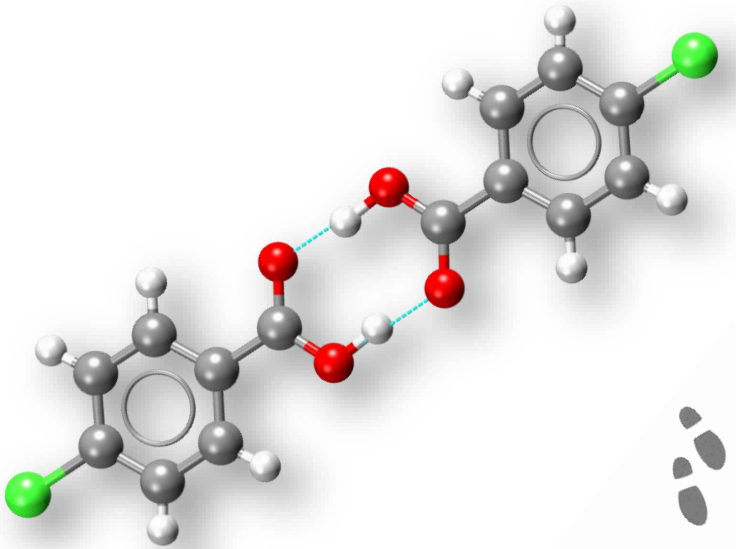
Aromatics Analyser Overview

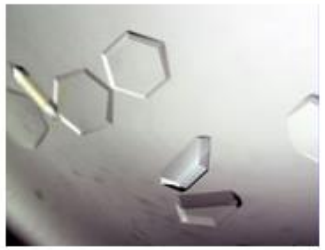
- CSD-Materials
  - Aromatics Analyser available in Mercury





Knowledge-based software can reinforce experimental findings





Isostar

ConQuest

Mogul

WebCSD

CSD

Mercury

In-house database

CSD Python API

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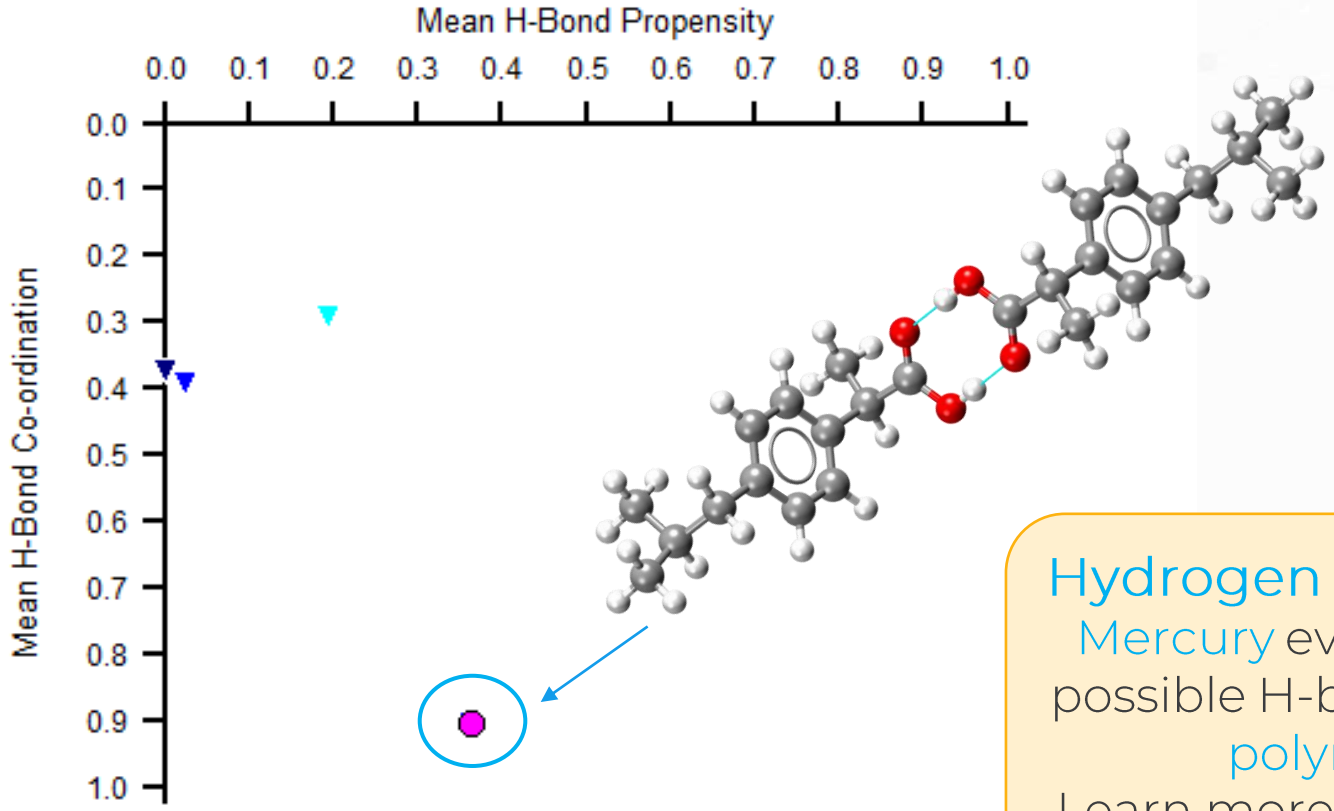
HBP shows only one point on the chart for the two forms of Ibuprofen



Hydrogen Bond Propensity (HBP) tool in Mercury evaluates the relative likelihoods of possible H-bonding networks in any observed polymorphs of a target system.
Learn more in the *Dictionary* on the handout.

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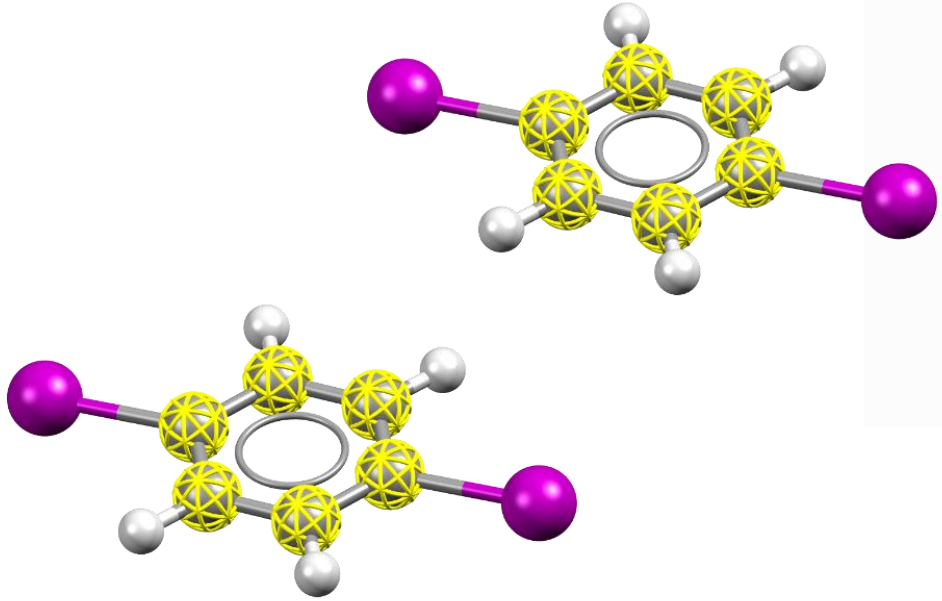
Other type of interactions can help distinguish between polymorphs



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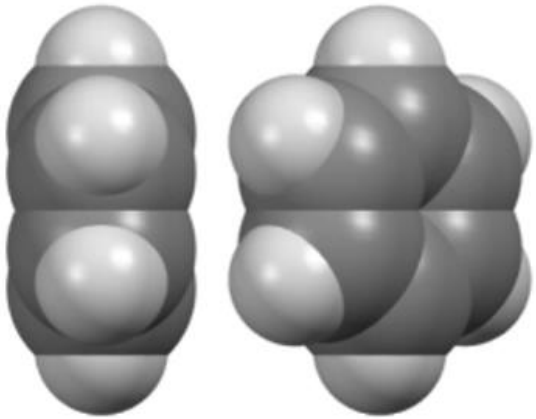
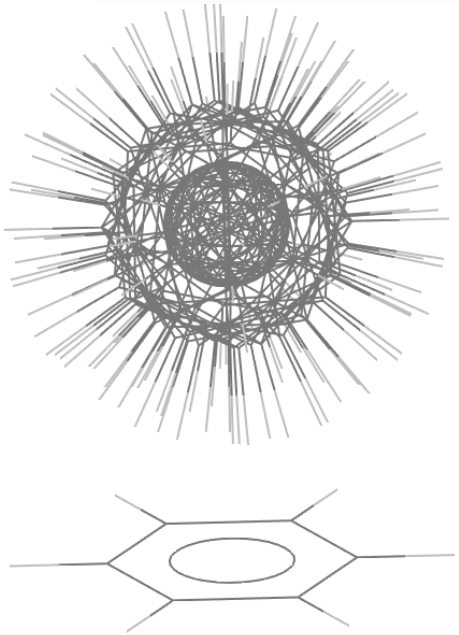
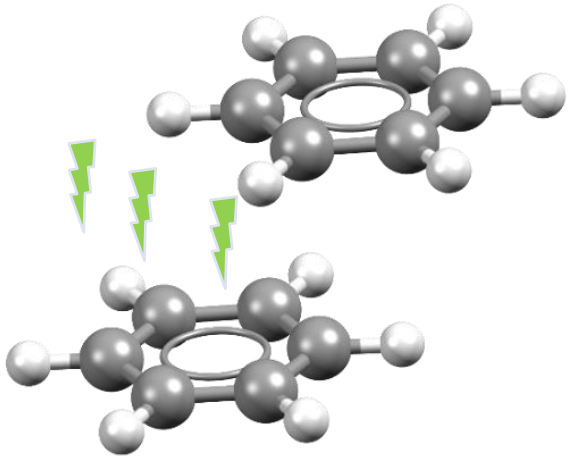
Covers large amount of orientations of the benzene rings

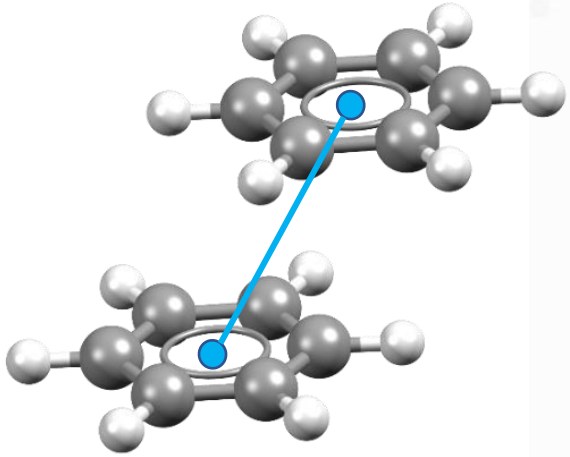




To predict aromatic interaction strengths we generated energies and molecular descriptors



Energy



Molecular descriptors

Machine Learning
Deep Neural Network

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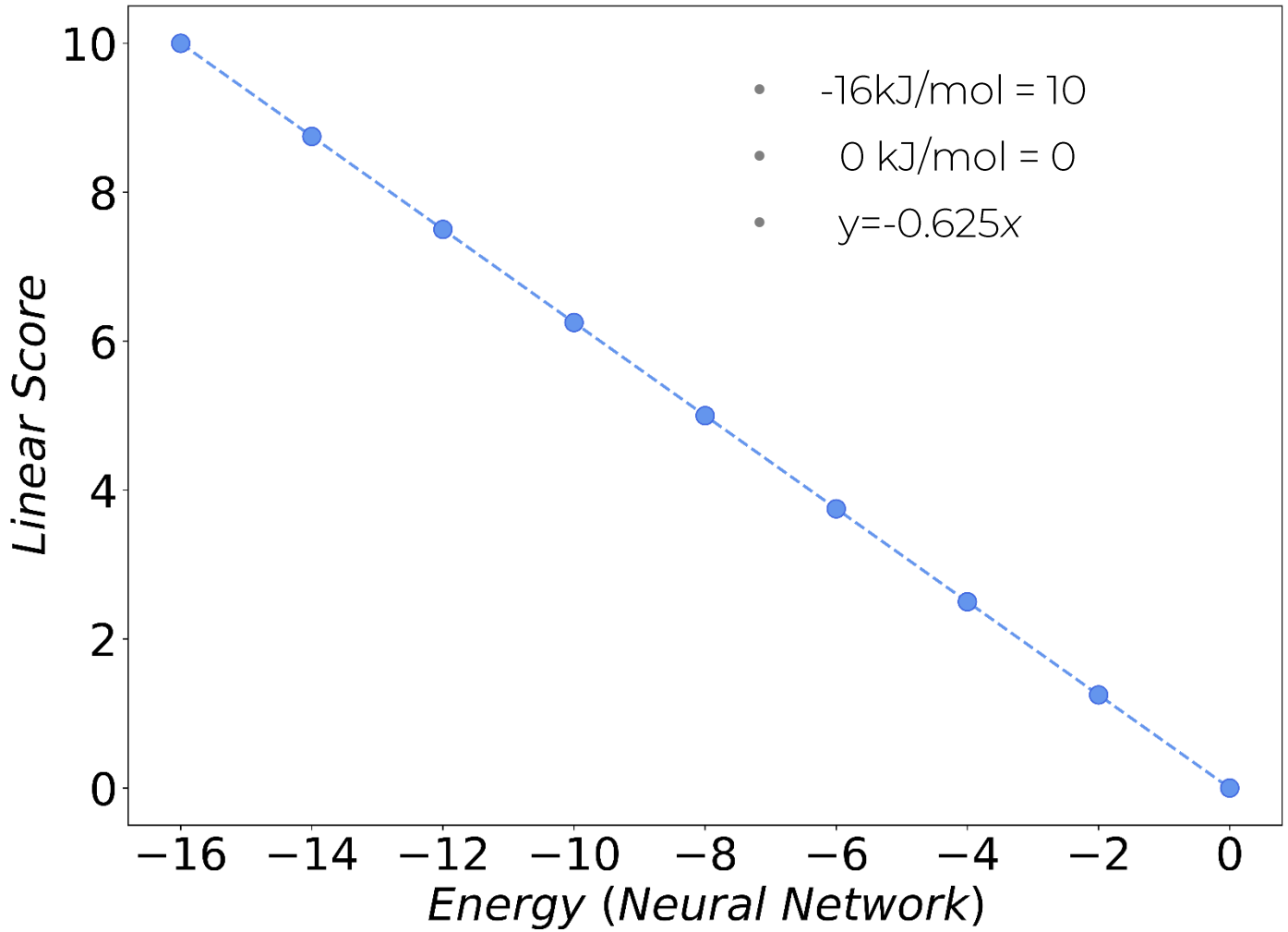
Linear scaling was generated (0 to 10)



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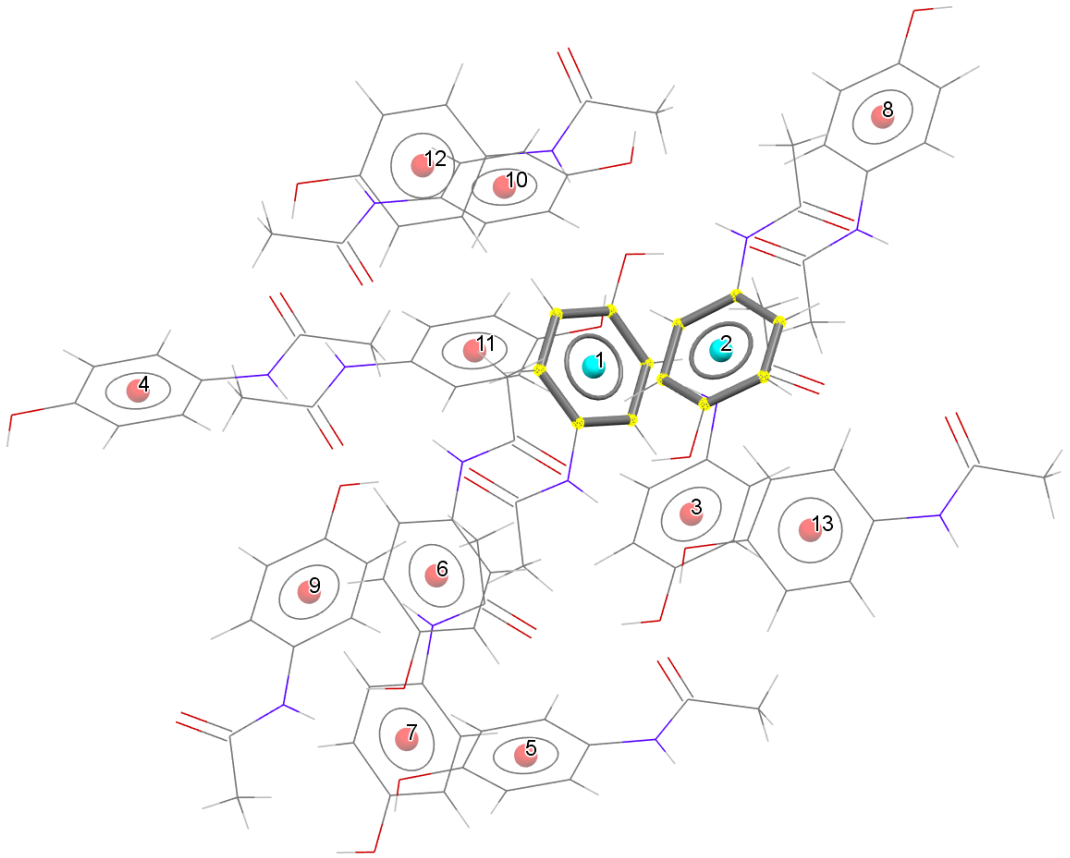
Aromatic Analyser allows interaction strength estimation for aromatics rings



Aromatics Analyser... HXACAN

Select atoms in just **one** molecule

	Centroid1	Centroid2	Distance	Relative Orientation	Inter-olecul	Score	Assessment
1	1	2	4.65	58.43	Yes	8.9	Strong
2	1	10	4.87	50.79	Yes	8	Strong
3	1	12	5.94	26.95	Yes	5.9	Moderate
4	1	7	8.93	0	Yes	0.6	Weak
5	1	8	8.6	58.43	Yes	0.6	Weak
6	1	6	9.38	0	Yes	0.4	Weak
7	1	4	9.88	50.79	Yes	0.2	Weak

☐ Include Intramolecular pairs ☑ Exclude symmetry equivalent interactions Calculate Export Atom info

Close

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Aromatic Analyser allows interaction strength estimation for aromatics rings

Aromatics Analyser... HXACAN01

Bond types may be edited using **Edit | Edit Structure...** from the main window

	Centroid1	Centroid2	Distance	Relative Orientation	Inter-molecular	Score	Assessment
1	1	10	4.74	0	Yes	8.1	Strong
2	1	8	5.26	0	Yes	6.9	Moderate
3	1	12	6.47	89.92	Yes	4.4	Moderate
4	1	9	7.18	0	Yes	2.1	Weak
5	1	6	7	89.92	Yes	2	Weak
6	1	11	7.22	89.92	Yes	1	Weak
7	1	2	8.58	89.92	Yes	0.6	Weak
8	1	3	9.2	89.92	Yes	0.4	Weak

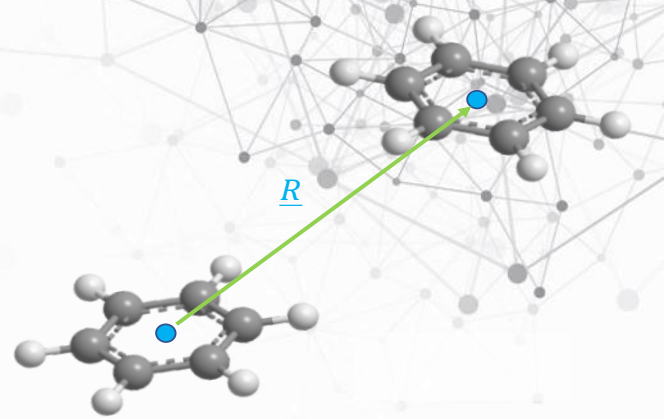
Strong (10 → 7):

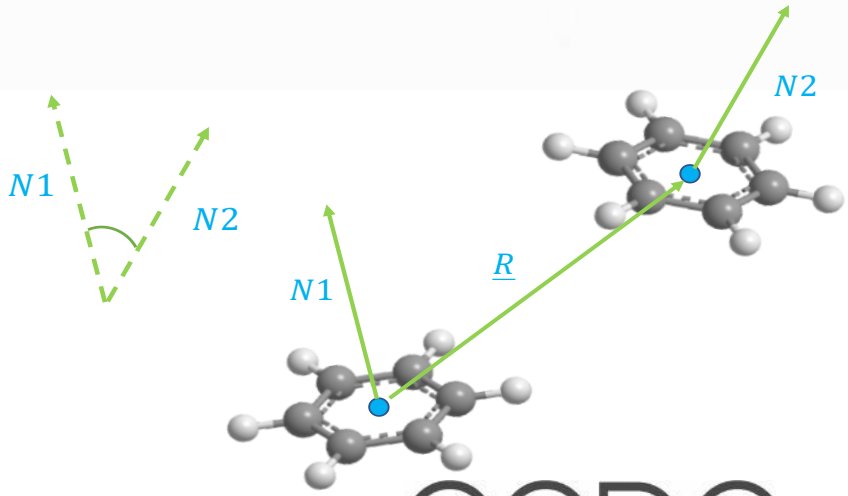
Moderate (7 → 3):

Weak (3 → 0):

Energy(kJ mol^{-1})
≤ -11.2
-11.2 < x ≤ -4.8
>-4.8

☐ Include Intramolecular pairs ☑ Exclude symmetry equivalent interactions | Calculate | Export | Atom info | Close





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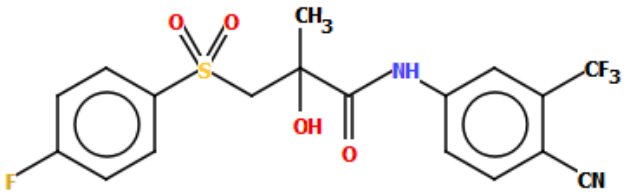
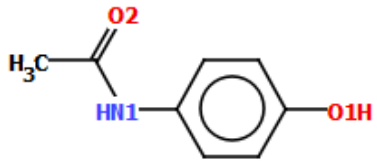
Investigating aromatic interactions for polymorphs

Polymorphs Different H-bonding



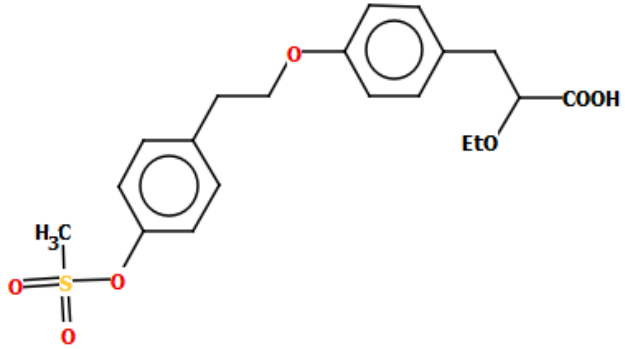
Bicalutamide
JAYCES (Form I)
JAYCES02 (Form II)

Polymorphs Same H-bonding



Paracetamol
HXACAN01 (Form I)
HXACAN (Forrm II)

Developed form Worst in HBP Needle morphology



Tesaglitazar
MATXUD

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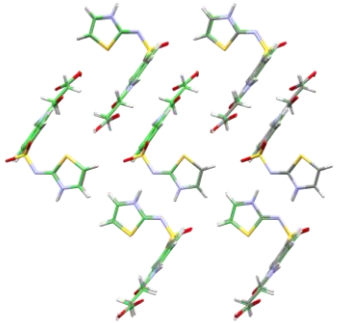
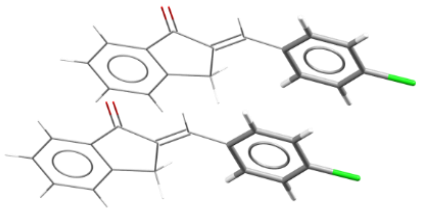
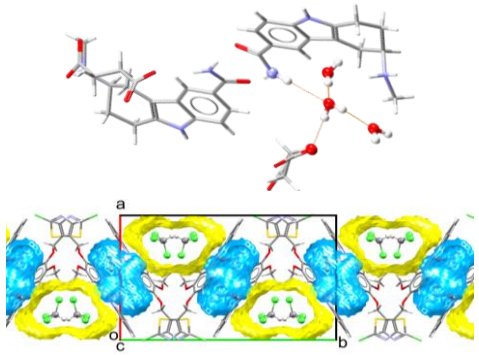
CSD-Materials overview



Crystal Packing Similarity

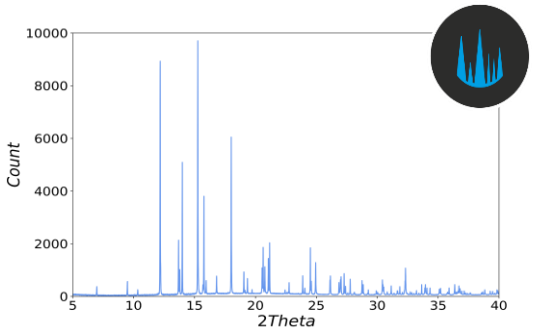


Motif Search & Packing Feature Search

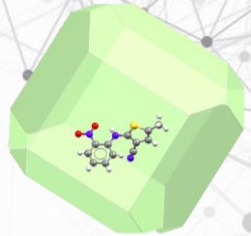


Hydrate Analyser & Solvate Analyser

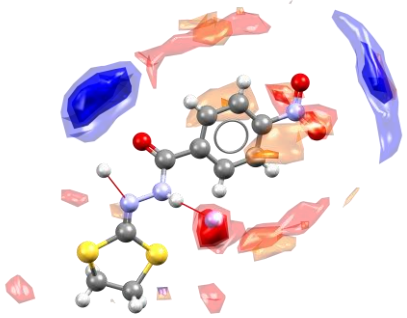
Detailed Structural Analysis



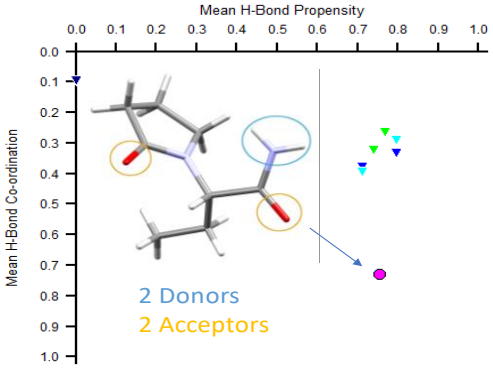
DASH



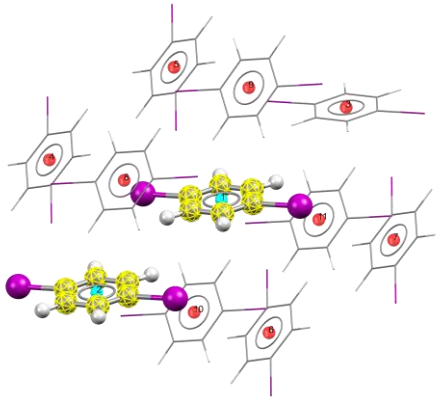
Calculations



Full Interaction Maps



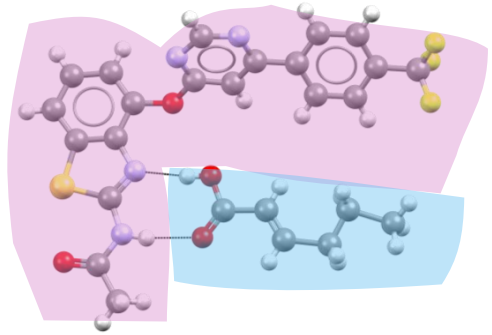
Hydrogen Bond Propensity



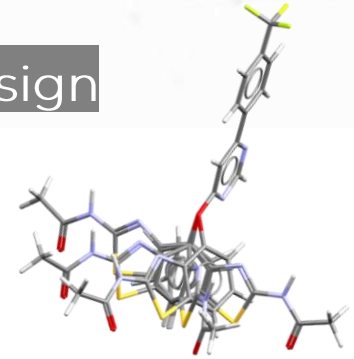
Aromatics Analyser

Solid Form Risk Assessment

Solid Form Design



Molecular Complementarity



CSD Conformer Generator

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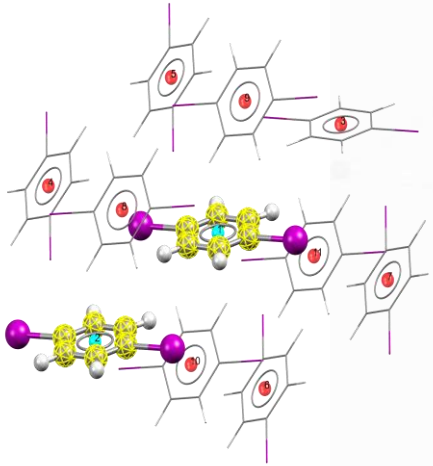
Machine Learning at CCDC

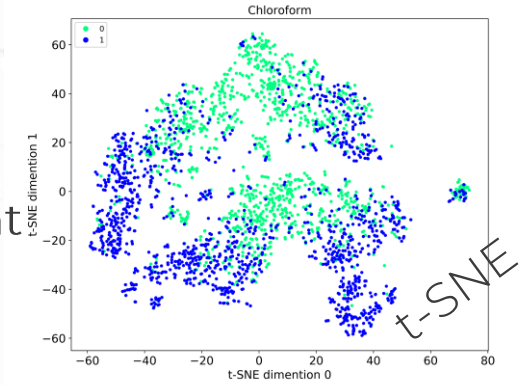
Logistic Regression
XGB
ANN

- Predicting physico-chemical
- Intermolecular interactions
- Co-crystal *in-silico* screening
- Particle properties



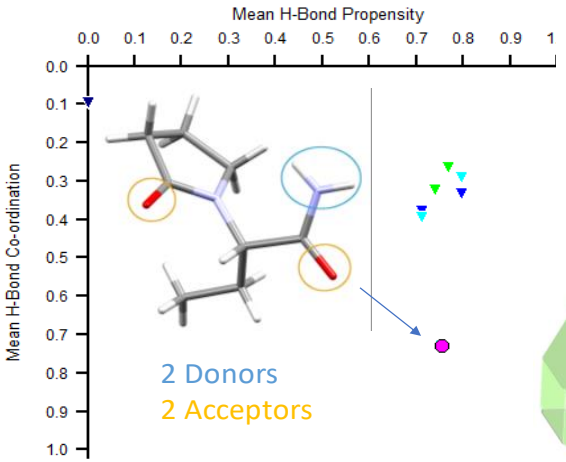
Aromatics Analyser QM

Melting Point

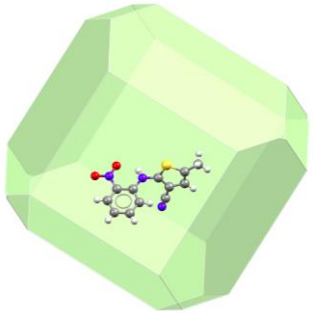


Solvation

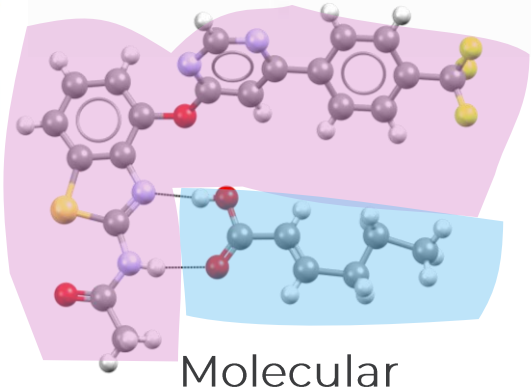
Crystallisation



Hydrogen Bond Propensi



Crystal morphology



Molecular Complementarity

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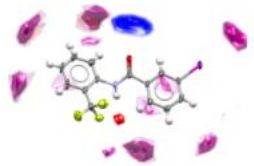
Want to explore more?



CSD-Materials

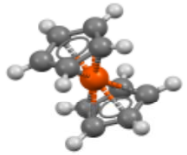
Tools to help you to understand your material's behaviours and refine its properties.

Educational Resources

The wealth of information contained within the Cambridge Structural Database (CSD) extends far beyond a collection of crystal structures. Knowledge derived from these materials informs much of chemistry, biochemistry, and biology. Chemical and structural concepts are often difficult to grasp without real world, interactive examples for students to explore.

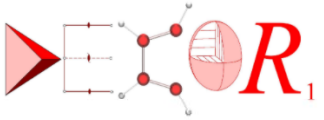
The CCDC and our colleagues continually produce educational materials for use in classroom and computer lab settings, or as independent study modules. Many of these materials make use of the Teaching Subset - a freely available set of over 750 structures that can be investigated with the free version of our Mercury visualisation and analysis program. Of course, our database of over one million entries are available for free through our Access Structures portal.

If you are an educator looking for supplementary teaching materials, find out more about the Teaching Database **here**. If you have developed your own modules using the CSD and would like to share them with the broader community, please contact us at education@ccdc.cam.ac.uk.



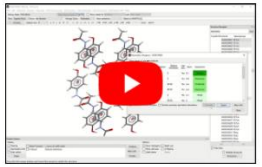
Information on the Teaching Subset

Access a series of teaching modules for use in the classroom

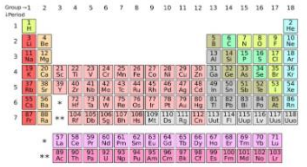


DECOR: Educational Resources for Teaching Crystallography

Download a series of self-guided workshop materials for CCDC tools and features



Watch software training and support videos



Explore the Periodic Table through Crystal Structures

Access fun science activities for kids through the CCDC Home learning page

Self-guided workshops https://www.ccdc.cam.ac.uk/Community/educationalresources/workshop-materials/csd-materials-workshops/

YouTube and LabTube channels links from https://www.ccdc.cam.ac.uk/Community/educationalresources/ccdc-videos/