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Leveraging KnowItAll Software's Data Mining Tools to Support NMR Analyses

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Introduction

Wiley's KnowItAll 2024 NMR tools were reengineered with a reimagined workflow that significantly improves usability and efficiency. KnowItAll software contains multiple applications that support different components of NMR analysis workflows, and the software itself is instrument neutral, allowing for the import of popular raw data formats.

In *ProcessIt*, users can process their raw spectra automatically or manually with the available tools. Users now have access to new NMR Tools in *MineIt*, which includes multiplet analysis, structure assignment, and automatic NMR report generation. The multiplet analysis has automatic and manual tools for coupling constant calculation and pattern assessment. KnowItAll also has an NMR prediction application called *PredictIt NMR*. Using this application, users can make spectral predictions using the Wiley NMR database collection, or train to their own records. The same Wiley NMR database collection is also available for searching (spectra, structures, metadata, etc.), containing more than 932,000 NMR spectra (^{13}C, ^{1}H, ^{15}N, ^{17}O, ^{19}F, ^{29}Si, ^{31}P,^{11}B).[1]

In this study, a complete NMR analysis is executed for 5-chloro-N-(2-hydroxyethyl)-1,8- naphthalimide, called **naphthalimide** using the KnowItAll 2024 software.

Method

A raw ^{1}H-NMR spectrum was measured in chloroform-d ($CDCl_3$) using a Bruker NMR. The KnowItAll software's *ProcessIt* and *MineIt* NMR tools were used for spectral processing and analysis. *PredictIt NMR*, which applies a HOSE code method, was used to perform ^{15}N-NMR spectral predictions. Structure searching was executed using the KnowItAll *SearchIt* application, where Tanimoto was selected as the searching algorithm from the 14 available similarity search methods. The Wiley and Wolfgang Robien ^{15}N-NMR libraries from the KnowItAll NMR Spectral Library[2] were used for the prediction calculations and database searching.

Results

The following steps were applied to process the raw file in *ProcessIt*: a default Fourier Transformation, default phasing method, NMR solvent referencing, integration, and peak picking. The final *ProcessIt* result is shown in Figure 1, displaying a completely processed ^{1}H-NMR spectrum that is ready for analysis.

The processed spectrum was added to a *MineIt* user-database where the new "NMR Tools" were used to evaluate the multiplets, and the analysis provided the splitting patterns, shifts, and coupling constants. This allowed for the ^{1}H-NMR report to be automatically generated, and the correct structure (as identified by the ^{1}H-NMR report) was attached to the record (see Figure 2). Finally, the multiplets were assigned to the structure for long-term archival and future searching, including storage of the auto-generated NMR report.

No X-NMR spectra were measured for this compound; however, it was possible to predict X-NMR spectra in lieu of this using *PredictIt NMR*. Thus, a prediction was made of the ^{15}N-NMR spectrum, and then this prediction was re-calculated by only applying records that were measured in $CDCl_3$ to improve the accuracy of the prediction. The nitrogen peak was calculated to be -280.41 using IUPAC standard of nitromethane (~100 ppm vs. NH_3)[3] (Figure 3). To investigate the validity of the predicted value, a similarity structure search against the ^{15}N-NMR libraries was performed in *SearchIt*, set to 50 best matches represented as "hits". Here, individual spectral records were reviewed to compare peak locations (Note: This can also be performed in the *PredictIt NMR* interface). The searching speed in KnowItAll was extremely fast, allowing for obtaining 50 matches in <1 second.

Figure 1: ^{1}H-NMR spectrum for the naphthalimide in $CDCl_3$; inset is focused to the aromatic region.

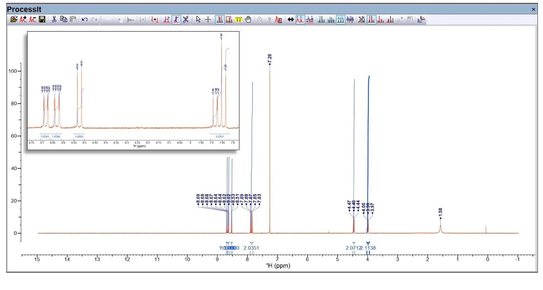


Figure 2: Completed *MineIt* record for the naphthalimide, including the autogenerated NMR report.

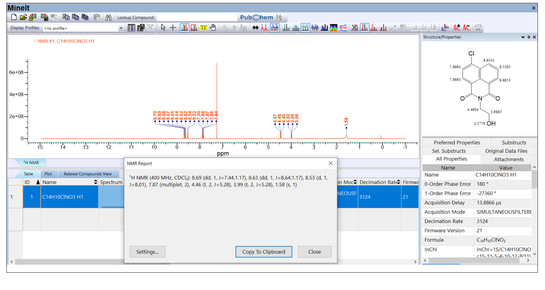


Figure 3: Predicted ^{15}N-NMR spectrum for the naphthalimide limited to $CDCl_3$ solvent.

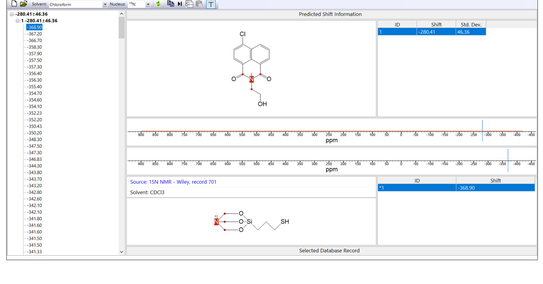
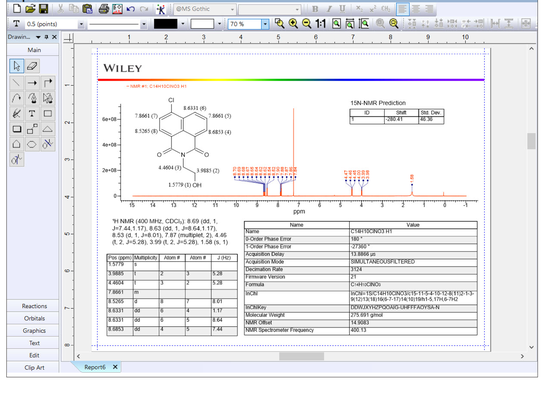


Figure 4: Automatic report generated from the *MineIt* record and transferred into *ReportIt*.



Summary

Results were transferred to *ReportIt* using a custom report template (Figure 4) in order to summarize the cumulation of information from the NMR analyses. Thus, KnowItAll 2024 allowed for complete spectral processing and analysis: from processing raw data, to databasing including structure drawing, then spectral predictions and database comparisons, and finally a cumulative report generation.

References

1. KnowItAll Analytical Edition (Version 24.0.59.0); John Wiley & Sons, Inc.: Hoboken, NJ, 2023. (accessed December 18, 2023).

2. KnowItAll NMR Spectral Library, John Wiley & Sons, Inc.: Hoboken, NJ, 2023. (accessed December 18, 2023).

3. Convert ^{15}N chemical shift to different standards. *Science and Fun (n.d.)*. https://www.science-and-fun.de/tools/15n-convert.html (accessed December 18, 2023).