1 A SIMPLIFIED OVERVIEW OF THE CHEMONTO METHODOLOGY

1.1 Reaction is Heck reaction as shown below:

$$PhI + CH_2 = CHPh \xrightarrow{Pd,\ PPh_3,\ N(Et)_3} (E) - Stilbene + (Z) - Stilbene + 1,1 - diphenylethylene$$

Steps to construct CHEMONTO knowledge:

Step: (1) Read the setup file in XYZ format. Step: (2) SUI Identification. Step: (3) Chemical Unit Identification, Step: (4) Reaction Center Identification, Step: (5) Constructing the hybridization of atoms.

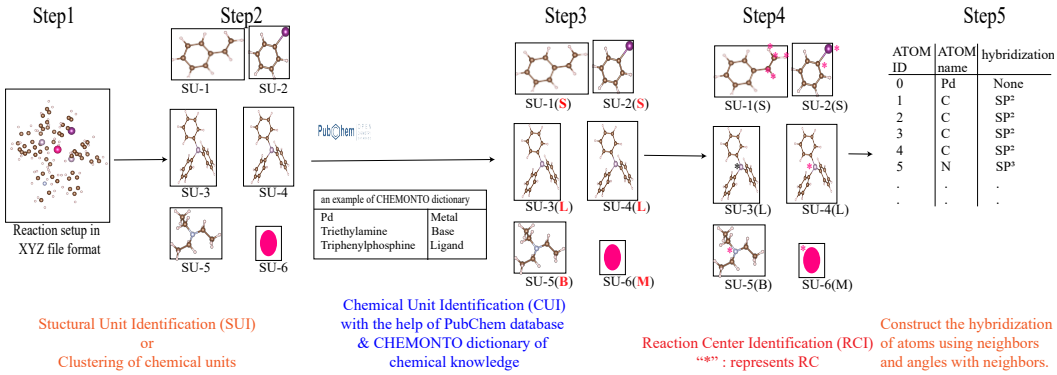

Fig. 1. The five basic steps of CHEMONTO . Step 1 corresponds to reading the setup file. Steps 2 and 3 address SUI and CUI, respectively. There are a total of six SUs. Step 3 further includes RCI; for example, the substrate PhI contains two RCs, styrene contains five RCs, while a ligand, a base, and a metal each contain one RC. The label M represents metal, L represents ligand, B represents base, and S represents substrate.

1.2 An example of ERPO of oxidative addition which provides paths to AFIR

$$(1)\ L_2Pd + PhI \xrightarrow{association} L_2Pd\cdots PhI \qquad \left(\equiv L_2Pd \begin{matrix} I \\ \diagup \\ \diagdown \\ Ph \end{matrix} \right)$$

$$(2)\ PhI \xrightarrow{dissociation} Ph + I$$

$$(3)\ L_2Pd + Ph \xrightarrow{association} L_2Pd - Ph$$

$$(4)\ L_2Pd - Ph + I \xrightarrow{association} L_2Pd \begin{matrix} \diagup Ph \\ \diagdown I \end{matrix}$$

In all the steps, it is assumed that both the Ls are attached to Pd. Steps (3) and (4) can be interchanged.

Figure 1, step 4 shows that the substrate PhI has two RCs and the metal Pd has one RC. If Pd_{Id}, Ph_{Id}, and I_{Id} are the reaction centers of Pd, Ph, and I, respectively, and d(X,Y) measures Euclidean distance between X and Y, then the following conditions have to be fulfilled for defining the oxidative addition.

1.3 An example of ERPO to find oxidative addition from reaction network:

(1) $d(I_{Id}, Ph_{Id}) > \delta$,
(2) $d(Pd_{Id}, Ph_{Id}) < \delta$,
(3) $d(Pd_{Id}, I_{Id}) < \delta$.

$\delta = 3.0$ Å. During the evaluation of the above distance criteria, atomic hybridizations are additionally considered to verify the validity of each SU through the allowed_changes option. For further details, please refer to the main manuscript.

Following a similar principle, other ERPOs can also be constructed. In CHEMONTO ERPOs are independent, which gives rise to the concept of overlapping ERPOs.