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**NAME**

TorsionAlertsUtil

**SYNOPSIS**

import TorsionAlertsUtil

**DESCRIPTION**

TorsionAlertsUtil module provides the following functions:

CalculateTorsionAngleDifference, DoesSMARTSContainValidSubClassMappedAtoms, DoesSMARTSContainValidTorsionRuleMappedAtoms, DoesSMARTSContainsMappedAtoms, FilterSubstructureMatchesByAtomMapNumbers, GetAtomPositions, GetGenericHierarchyClassElementNode, GetHeavyAtomNeighbors, IdentifyRotatableBondsForTorsionLibraryMatch, IsSpecificHierarchyClass, ListTorsionLibraryInfo, RemoveLastHierarchyClassElementNodeFromTracking, RemoveLastHierarchySubClassElementNodeFromTracking, RetrieveTorsionLibraryInfo, SetupHierarchyClassAndSubClassNamesForRotatableBond, SetupHierarchySubClassElementPatternMol, SetupTorsionLibraryInfoForMatchingRotatableBonds, SetupTorsionRuleAnglesInfo, SetupTorsionRuleElementPatternMol, TrackHierarchyClassElementNode, TrackHierarchySubClassElementNode

**FUNCTIONS****CalculateTorsionAngleDifference**

```
CalculateTorsionAngleDifference(TorsionAngle1, TorsionAngle2)
```

Calculate torsion angle difference in the range from 0 to 180.

**Arguments:**

```
TorsionAngle1 (float): First torsion angle.  
TorsionAngle2 (float): Second torsion angle.
```

**Returns:**

```
float: Difference between first and second torsion angle.
```

**DoesSMARTSContainValidSubClassMappedAtoms**

```
DoesSMARTSContainValidSubClassMappedAtoms(SMARTS)
```

Check for the presence of two central mapped atoms in SMARTS pattern. A valid SMARTS pattern must contain only two mapped atoms corresponding to map atom numbers ':2' and ':3'.

**Arguments:**

```
SMARTS (str): SMARTS pattern for sub class in torsion library XML tree.
```

**Returns:**

```
bool: True - A valid pattern; Otherwise, false.
```

**DoesSMARTSContainValidTorsionRuleMappedAtoms**

```
DoesSMARTSContainValidTorsionRuleMappedAtoms(SMARTS)
```

Check for the presence of four mapped atoms in a SMARTS pattern. A valid SMARTS pattern must contain only four mapped atoms corresponding to map atom numbers ':1', ':2', ':3' and ':4'.

**Arguments:**

```
SMARTS (str): SMARTS pattern for torsion rule in torsion library XML  
tree.
```

**Returns:**

```
bool: True - A valid pattern; Otherwise, false.
```

**DoesSMARTSContainsMappedAtoms**

```
DoesSMARTSContainsMappedAtoms(SMARTS, MappedAtomNumsList)
```

Check for the presence of specified mapped atoms in SMARTS pattern. The mapped atom numbers in the list are specified as ':1', ':2', ':3' etc.

**Arguments:**

SMARTS (str): SMARTS pattern in torsion library XML tree.  
MappedAtoms (list): Mapped atom numbers as ":1", ":2" etc.

**Returns:**

bool: True - All mapped atoms present in pattern; Otherwise, false.

### FilterSubstructureMatchesByAtomMapNumbers

FilterSubstructureMatchesByAtomMapNumbers(Mol, PatternMol, AtomIndicesList)

Filter a list of lists containing matched atom indices by map atom numbers present in a pattern molecule. The list of atom indices correspond to a list retrieved by RDKit function GetSubstructureMatches using SMILES/SMARTS pattern. The atom map numbers are mapped to appropriate atom indices during the generation of molecules. For example: [O:1]=[S:2](=[O])[C:3][C:4].

**Arguments:**

Mol (object): RDKit molecule object.  
PatternMol (object): RDKit molecule object for a SMILES/SMARTS pattern.  
AtomIndicesList (list): A list of lists containing atom indices.

**Returns:**

list : A list of lists containing filtered atom indices.

### GetAtomPositions

GetAtomPositions(Mol, ConfID = -1)

Retrieve a list of lists containing coordinates of all atoms in a molecule.

**Arguments:**

Mol (object): RDKit molecule object.  
ConfID (int): Conformer number.

**Returns:**

list : List of lists containing atom positions.

**Example(s):**

```
for AtomPosition in TorsionAlertsUtil.GetAtomPositions(Mol):  
    print("X: %s; Y: %s; Z: %s" % (AtomPosition[0], AtomPosition[1], AtomPosition[2]))
```

### GetGenericHierarchyClassElementNode

GetGenericHierarchyClassElementNode(TorsionLibraryInfo)

Get generic hierarchy class element node.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.

**Returns:**

object: Generic hierarchy class element node in torsion library XML tree.

### GetHeavyAtomNeighbors

GetHeavyAtomNeighbors(Atom)

Get a list of heavy atom neighbors.

**Arguments:**

Atom (object): RDKit atom object.

**Returns:**

list : List of heavy atom neighbors.

**IdentifyRotatableBondsForTorsionLibraryMatch**

```
IdentifyRotatableBondsForTorsionLibraryMatch(TorsionLibraryInfo, Mol,
RotBondsPatternMol)
```

Identify rotatable bonds in a molecule for torsion library match.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.  
Mol (object): RDKit molecule object.  
RotBondsPatternMol (object): RDKit molecule object for SMARTS pattern corresponding to rotatable bonds.

**Returns:**

bool: True - Rotatable bonds present in molecule; Otherwise, false.  
None or dict: None - For no rotatable bonds in molecule; otherwise, a dictionary containing the following informations for rotatable bonds matched to RotBondsPatternMol:

```
RotBondsInfo["IDs"] = []
RotBondsInfo["AtomIndices"] = {}
RotBondsInfo["HierarchyClass"] = {}
```

**IsSpecificHierarchyClass**

```
IsSpecificHierarchyClass(TorsionLibraryInfo, HierarchyClass)
```

Check whether it's a specific hierarchy class.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.  
HierarchyClass (str): Hierarchy class name.

**Returns:**

bool: True - A valid hierarchy class name; Otherwise, false.

**ListTorsionLibraryInfo**

```
ListTorsionLibraryInfo(TorsionLibElementTree)
```

List torsion library information using XML tree object. The following information is listed:

**Summary:**

```
Total number of HierarchyClass nodes: <Number>
Total number of HierarchyClassSubClass nodes: <Number>
Total number of TorsionRule nodes: <Number>
```

**Details:**

```
HierarchyClass: <Name>; HierarchySubClass nodes: <Number>;
TorsionRule nodes: <SMARTS>
... ..
```

**Arguments:**

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TorsionLibElementTree (object): XML tree object.

**Returns:**

Nothing.

#### RemoveLastHierarchyClassElementNodeFromTracking

RemoveLastHierarchyClassElementNodeFromTracking(TorsionLibraryInfo)

Remove last hierarchy class element node from tracking by removing it from a stack.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.

**Returns:**

Nothing. The torsion library info is updated.

#### RemoveLastHierarchySubClassElementNodeFromTracking

RemoveLastHierarchySubClassElementNodeFromTracking(TorsionLibraryInfo)

Remove last hierarchy sub class element node from tracking by removing it from a stack.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.

**Returns:**

Nothing. The torsion library info is updated.

#### RetrieveTorsionLibraryInfo

RetrieveTorsionLibraryInfo(TorsionLibraryFilePath, Quiet = True)

Retrieve torsion library information.

**Arguments:**

TorsionLibraryFilePath (str): Torsion library XML file path.

**Returns:**

object: An object returned by xml.etree.ElementTree.parse function.

The XML file is parsed using xml.etree.ElementTree.parse function and object created by the parse function is simply returned.

#### SetupHierarchyClassAndSubClassNamesForRotatableBond

SetupHierarchyClassAndSubClassNamesForRotatableBond(TorsionLibraryInfo)

Setup hierarchy class and subclass names for a rotatable bond matched to a torsion rule element node.

**Returns:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.

str: A back slash delimited string containing hierarchy class names at the level of torsion rule element node.

str: A back slash delimited string containing hierarchy sub class names at the level of torsion rule element node.

#### SetupHierarchySubClassElementPatternMol

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```
SetupHierarchySubClassElementPatternMol(TorsionLibraryInfo, ElementNode)
```

Setup pattern molecule for SMARTS pattern in hierarchy subclass element.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.

ElementNode (object): A hierarchy sub class element node being matched in torsion library XML tree.

**Returns:**

object: RDKit molecule object corresponding to SMARTS pattern for hierarchy sub class element node.

SetupTorsionLibraryInfoForMatchingRotatableBonds

```
SetupTorsionLibraryInfoForMatchingRotatableBonds(TorsionLibraryInfo)
```

Setup torsion library information for matching rotatable bonds. The following information is initialized and updated in torsion library dictionary for matching rotatable bonds:

```
TorsionLibraryInfo["GenericClass"] = None
TorsionLibraryInfo["GenericClassElementNode"] = None

TorsionLibraryInfo["SpecificClasses"] = {}
TorsionLibraryInfo["SpecificClasses"]["Names"] = []
TorsionLibraryInfo["SpecificClasses"]["ElementNode"] = {}

TorsionLibraryInfo["HierarchyClassNodes"] = []
TorsionLibraryInfo["HierarchySubClassNodes"] = []

TorsionLibraryInfo["DataCache"] = {}
TorsionLibraryInfo["DataCache"]["SubClassPatternMol"] = {}

TorsionLibraryInfo["DataCache"]["TorsionRulePatternMol"] = {}
TorsionLibraryInfo["DataCache"]["TorsionRuleAnglesInfo"] = {}
```

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing root node for torsion library element tree.

**Returns:**

Nothing. The torsion library information dictionary is updated.

SetupTorsionRuleAnglesInfo

```
SetupTorsionRuleAnglesInfo(TorsionLibraryInfo, TorsionRuleElementNode)
```

Setup torsion angles and energy info for matching a torsion rule.

**Arguments:**

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.

TorsionRuleElementNode (object): A torsion rule element node being matched in torsion library XML tree.

**Returns:**

dict: A dictionary containing the following information for torsion rule being matched to a rotatable bond:

```
RuleAnglesInfo = {}

RuleAnglesInfo["IDs"] = []
```

```
RuleAnglesInfo["Value"] = {}
RuleAnglesInfo["Score"] = {}
RuleAnglesInfo["Tolerance1"] = {}
RuleAnglesInfo["Tolerance2"] = {}

RuleAnglesInfo["ValuesList"] = []
RuleAnglesInfo["ValuesIn360RangeList"] = []
RuleAnglesInfo["Tolerances1List"] = []
RuleAnglesInfo["Tolerances2List"] = []

# Strain energy calculations...
RuleAnglesInfo["EnergyMethod"] = None
RuleAnglesInfo["EnergyMethodExact"] = None
RuleAnglesInfo["EnergyMethodApproximate"] = None

# For approximate strain energy calculation...
RuleAnglesInfo["Beta1"] = {}
RuleAnglesInfo["Beta2"] = {}
RuleAnglesInfo["Theta0"] = {}

# For exact strain energy calculation...
RuleAnglesInfo["HistogramEnergy"] = []
RuleAnglesInfo["HistogramEnergyLowerBound"] = []
RuleAnglesInfo["HistogramEnergyUpperBound"] = []
```

#### SetupTorsionRuleElementPatternMol

```
SetupTorsionRuleElementPatternMol(TorsionLibraryInfo, ElementNode, TorsionRuleNodeID,
TorsionSMARTSPattern)
```

Setup pattern molecule for SMARTS pattern in torsion rule element.

##### *Arguments:*

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.  
ElementNode (object): A torsion rule element node being matched in torsion library XML tree.  
TorsionRuleNodeID (int): Torsion rule element node ID.  
TorsionSMARTSPattern (str): SMARTS pattern for torsion rule element node.

##### *Returns:*

object: RDKit molecule object corresponding to SMARTS pattern for torsion rule element node.

#### TrackHierarchyClassElementNode

```
TrackHierarchyClassElementNode(TorsionLibraryInfo, ElementNode)
```

Track hierarchy class element node using a stack.

##### *Arguments:*

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.  
ElementNode (object): Hierarchy class element node in torsion library XML tree.

##### *Returns:*

Nothing. The torsion library info is updated.

#### TrackHierarchySubClassElementNode

```
TrackHierarchySubClassElementNode(TorsionLibraryInfo, ElementNode)
```

Track hierarchy sub class element node using a stack.

*Arguments:*

TorsionLibraryInfo (dict): A dictionary containing information for matching rotatable bonds.  
ElementNode (object): Hierarchy sub class element node in torsion library XML tree.

*Returns:*

Nothing. The torsion library info is updated.

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