

# **SKETCH-BASED SERVICES**

## **Visual-Conceptual Relationship Suggestions in Natural Language**

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# Key Results

1. **VCR suggestions integrated with Verbalize for `insideInSketch` (17 relations) and `atOrOverlapsInSketch` (43 relations).**
2. **Additional integration with Multimodal Interpretation Group (12 relations).**
3. **Absence of `genFormat` returns `nil`, serving as a filter for suggestions that can't be clearly/concisely explained.**
4. **Symmetric relations are handled in order to filter redundant suggestions (e.g., “Is A adjacent to B?” appearing once).**

# Original vs. Current Results

## Visual/Conceptual Relations

### Subsketch Subsketch A:

Conceptual relationships between Circle and Square:

((PredicateIntersection2Fn touches-Directly surroundsCompletely) Square Circle)  
 ((PredicateIntersection2Fn touches-Directly surroundsCompletely) Circle Square)  
 (adjacentTo Square Circle)  
 (adjacentTo Circle Square)  
 (aligned Square Circle)  
 (aligned Circle Square)  
 (alignedAlong Square Circle)  
 (alignedAlong Circle Square)  
 (alignedAlongLength Square Circle)  
 (alignedAlongLength Circle Square)  
 (alignedAlongSurface Square Circle)  
 (alignedAlongSurface Circle Square)  
 (alignedCylinderWithin Square Circle)  
 (alignedCylinderWithin Circle Square)  
 (alignedEndToEnd Square Circle)  
 (alignedEndToEnd Circle Square)  
 (approximatelyLocatedAt-Spatial Square Circle)  
 (approximatelyLocatedAt-Spatial Circle Square)  
 (componentPartOfSpaceRegion Square Circle)  
 (componentPartOfSpaceRegion Circle Square)  
 (connectedSpaceRegions Square Circle)  
 (connectedSpaceRegions Circle Square)  
 (connectsWithAtomicTPPOfSpaceRegion Square Circle)  
 (connectsWithAtomicTPPOfSpaceRegion Circle Square)  
 (convexHullOf Circle Square)  
 (cospatial Square Circle)  
 (cospatial Circle Square)  
 (crossSections Square Circle)  
 (crossSections Circle Square)

## Visual/Conceptual Relations

### Subsketch Subsketch A:

Conceptual relationships between Circle and Square:

Is Circle adjacent to Square?  
 Is Circle aligned with Square?  
 Is Circle aligned along Square?  
 Is Square aligned along the length of Circle?  
 Is Circle aligned along the length of Square?  
 Is Square aligned along the surface of Circle?  
 Circle touches Square over a significant extent of its surface  
 Is Square inside and aligned along cylinder-like element Circle?  
 Circle is inside and aligned along the axis of Square  
 Is Circle aligned end to end with Square?  
 Is Square approximately located at Circle?  
 Is Circle approximately located at Square?  
 Are Circle and Square spatially connected regions?  
 Is Circle the convex hull of Square?  
 Is Circle in a cospatial relationship with Square?  
 Is Square a cross section of Circle?  
 Is Circle a cross section of Square?  
 Is Square exactly located at the space of Circle?  
 Is Circle exactly located at the space of Square?  
 Are Circle and Square externally connected regions?  
 Does Square form part of the border of Circle?  
 Does Circle form part of the border of Square?  
 Are Circle and Square identical regions?  
 Is Circle an end of linear object Square?  
 Is Square an object that edges Circle?  
 Does Square occupy most of Circle?  
 Does Circle occupy most of Square?  
 Is Square on a linear object Circle?  
 Are Circle and Square overlapping regions?

# Micro-Theory CogSketchNLG2nt

```
13 (in-microtheory CogSketchNLG2nt)
14 (genFormat in-ImmersedFully "Is ~A fully immersed in ~A?" (TheList 1 2))
15 (genFormat inRegion "Is ~A in region ~A?" (TheList 1 2))
16 (genFormat constituents "Is ~A a constituent of ~A?" (TheList 1 2))
17 (genFormat cospatial "Is ~A in a cospatial relationship with ~A?" (TheList 1 2))
18 (genFormat externalParts "Is ~A an external part of ~A?" (TheList 1 2))
19 (genFormat hasStoredInside "Is ~A stored inside of ~A?" (TheList 1 2))
20 (genFormat in-Among "Is ~A among ~A?" (TheList 1 2))
21 (genFormat in-EmbeddedInFluidMatrix "Is ~A embedded in fluid matrix in ~A?" (TheList 1 2))
22 (genFormat in-PassesThrough "Does ~A pass through ~A?" (TheList 1 2))
23 (genFormat internalParts "Is ~A an internal part of ~A?" (TheList 1 2))
24 (genFormat internalSubRegions "Is ~A an internal subregion of ~A?" (TheList 1 2))
25 (genFormat mainConstituent "Is ~A the main constituent of ~A?" (TheList 1 2))
26 (genFormat mainFunctionalComponent "Is ~A the main functional constituent of ~A?" (TheList 1 2))
27 (genFormat objectFoundInLocation "Is ~A an object found in location of ~A?" (TheList 1 2))
28 (genFormat physicalParts "Is ~A a physical part of ~A?" (TheList 1 2))
29 (genFormat physicallyContains "Is ~A physically contained in ~A?" (TheList 1 2))
30 (genFormat primaryConstituent "Is ~A a primary constituent of ~A?" (TheList 1 2))
31 (genFormat cordEnd "Is ~A at the end of cordlike object ~A?" (TheList 1 2))
32 (genFormat connectedTo "Is ~A connected to ~A?" (TheList 1 2))
33 (genFormat connectedAtEnd "Is ~A connected at the end of ~A?" (TheList 1 2))
34 (genFormat connectedAtContact "Is ~A connected to ~A at a point of contact?" (TheList 1 2))
35 (genFormat connectedAtSpot "Is ~A connected to ~A at a localized spot?" (TheList 1 2))
36 (genFormat connectedAlongSurface "Is ~A connected along the surface of ~A?" (TheList 1 2))
37 (genFormat surfaceParts "Is ~A a surface part of ~A?" (TheList 1 2))
38 (genFormat surrounds-3D "Does ~A surround ~A along all the three dimensions?" (TheList 1 2))
39 (genFormat coversPartially "Does ~A partially cover ~A?" (TheList 1 2))
40 (genFormat alignedCylinderWithin "Is ~A inside and aligned along cylinder-like element ~A?" (TheList 1 2))
41 (genFormat spiralsAround "Does ~A spiral around ~A?" (TheList 1 2))
42 (genFormat alignedAlongLength "Is ~A aligned along the length of ~A?" (TheList 1 2))
43 (genFormat adjacentTo "Is ~A adjacent to ~A?" (TheList 1 2))
44 (genFormat aligned "Is ~A aligned with ~A?" (TheList 1 2))
45 (genFormat alignedAlong "Is ~A aligned along ~A?" (TheList 1 2))
46 (genFormat alignedAlongSurface "Is ~A aligned along the surface of ~A?" (TheList 1 2))
47 (genFormat alignedEndToEnd "Is ~A aligned end to end with ~A?" (TheList 1 2))
48 (genFormat approximatelyLocatedAt-Spatial "Is ~A approximately located at ~A?" (TheList 1 2))
49 (genFormat whollyLocatedAt-Spatial "Is ~A entirely located in the space of ~A?" (TheList 1 2))
50 (genFormat exactlyLocatedAt-Spatial "Is ~A exactly located at the space of ~A?" (TheList 1 2))
51 (genFormat partiallyLocatedAt-Spatial "Is ~A partially located in the space of ~A?" (TheList 1 2))
52 (genFormat connectedSpaceRegions "Are ~A and ~A spatially connected regions?" (TheList 1 2))
53 (genFormat convexHullOf "Is ~A the convex hull of ~A?" (TheList 1 2))
54 (genFormat crossSections "Is ~A a cross section of ~A?" (TheList 1 2))
55 (genFormat externallyConnectedSpaceRegions "Are ~A and ~A externally connected regions?" (TheList 1 2))
56 (genFormat formsBorderPart "Does ~A form part of the border of ~A?" (TheList 1 2))
57 (genFormat identicalSpaceRegions "Are ~A and ~A identical regions?" (TheList 1 2))
58 (genFormat linearObjectEnds "Is ~A an end of linear object ~A?" (TheList 1 2))
59 (genFormat objectEdges "Is ~A an object that edges ~A?" (TheList 1 2))
60 (genFormat occupiesMostOf "Does ~A occupy most of ~A?" (TheList 1 2))
61 (genFormat online "Is ~A on a linear object ~A?" (TheList 1 2))
62 (genFormat overlappingSpaceRegions "Are ~A and ~A overlapping regions?" (TheList 1 2))
63 (genFormat partOfSpaceRegion "Is ~A part of region ~A?" (TheList 1 2))
64 (genFormat partiallyOverlappingSpaceRegions "Does ~A partially overlap region ~A?" (TheList 1 2))
65 (genFormat partiallySpatiallyIntersects "Does ~A partially intersect space of ~A?" (TheList 1 2))
66 (genFormat properPartOfSpaceRegion "Is ~A a proper part of region ~A?" (TheList 1 2))
67 (genFormat spatiallyIntersects "Does ~A spatially intersect ~A?" (TheList 1 2))
68 (genFormat spatiallySubsumes "Does ~A spatially subsume ~A?" (TheList 1 2))
69 (genFormat touches "Does ~A touch ~A?" (TheList 1 2))
70 (genFormat touches-Externally "Does ~A externally touch ~A?" (TheList 1 2))
71 (genFormat stronglyConnectedSpaceRegions "Are ~A and ~A strongly connected regions?" (TheList 1 2))
```

(genFormat adjacentTo  
"Is ~A adjacent to ~A?"  
(TheList 1 2))

# Function `print-vcr-reln-select`

```
(defun print-vcr-reln-select (names relns q-idx)

  ...

  (dolist (reln relns)
    (let ((pretty-exp (fire:verbalize (sublis names (first reln))
                                     :context 'd::CogSketchNLG2Mt
                                     :fallback nil)))
      (when pretty-exp
        (net.html.generator:html
         (:newline)
         ((:option value
                  (format-relation-predicate (car reln) names))
          (:princ pretty-exp))))))))))
```

# Before & After Filtering

## Subsketch Subsketch A:

Conceptual relationships between Circle and Square:

- Is Square adjacent to Circle?
- Is Circle adjacent to Square?
- Is Square aligned with Circle?
- Is Circle aligned with Square?
- Is Square aligned along Circle?
- Is Circle aligned along Square?
- Is Square aligned along the length of Circle?
- Is Circle aligned along the length of Square?

## Subsketch Subsketch A:

Conceptual relationships between Circle and Square:

- Is Circle adjacent to Square?
- Is Circle aligned with Square?
- Is Circle aligned along Square?
- Is Square aligned along the length of Circle?
- Is Circle aligned along the length of Square?
- Is Square aligned along the surface of Circle?



# Function `filter-symmetric-relns`

```
(defun filter-symmetric-relns (possible-relns)
  (remove-duplicates
   possible-relns
   :test #'(lambda (x y)
              (let ((exp1 (first x))
                    (exp2 (first y)))
                ;; expn = (relation object1 object2)
                (and (equal (first exp1) (first exp2))
                     (equal (second exp1) (third exp2))
                     (equal (second exp2) (third exp1))
                     (kb:instance-of? (first exp1)
                                       'd::SymmetricRelation
                                       'd::EverythingPSC)))))))
```

# Questions & Comments:

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